IPC-2546

Sectional Requirements for Shop-Floor Equipment Communication Messages (CAMX) for Printed Circuit Board Assembly

Amendment 2:

Dispensing Equipment Section
Reflow Equipment Section
Final Assembly and Packaging Section

IPC-2546
January 2005

A standard developed by IPC

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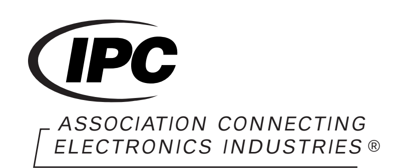

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Sectional Requirements for Shop-Floor Equipment Communication Messages (CAMX) for Printed Circuit Board Assembly

Amendment 2:

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Reflow Equipment Section
Final Assembly and Packaging Section

A standard developed by the Assembly XML Schema Formatting Task Group (2-13b) of the Shop Floor Communications Subcommittee (2-13) of IPC.

Users of this publication are encouraged to participate in the development of future revisions.

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Acknowledgment

Any document involving a complex technology draws material from a vast number of sources. While the principal members of the Assembly XML Schema Formatting Task Group (2-13b) of the Shop Floor Communications Subcommittee (2-13) are shown below, it is not possible to include all of those who assisted in the evolution of this standard. To each of them, the members of the IPC extend their gratitude.

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IPC-2501 Definition for Web-Based Exchange of XML Data (Message Broker)

IPC-2541 Generic Requirements for Electronics Manufacturing Shop-Floor Equipment Communication Messages (CAMX)

IPC-2547 Sectional Requirements for Shop-Floor Equipment Communication Messages (CAMX) for Printed Circuit Board Test, Inspection and Rework

3.1 Date and Time Notation

Part 2: Datatypes
http://www.w3.org/TR/xmlschema-2/
dateTime
http://www.w3.org/TR/xmlschema-2/#dateTime
Format: yyyy**-**MM**-**dd**T**hh**:**mm**:**ss**.**sss±zz:zz

duration
http://www.w3.org/TR/xmlschema-2/#duration
Format: **P***n*Y*n*M*n*D**T***n*H*n*M*n*S

4 GENERIC ASSEMBLY EQUIPMENT EVENTS AND MESSAGE FORMATS

4.1 Dictionary of Common Terms

Add the following terms to section 4.1:

Dual Lane

A transport system with two independent lanes used to transport product through the equipment.

Transport Direction

The direction the items travel through the machine. A machine is usually set up for a right-to-left or left-to-right direction.

4.4 Dictionary of Nested Elements

Add the following elements to Section 4.4:

4.4.7 Element: EnvironmentalControlUnit

Description: This element can be used to generically describe an environmental control unit. It can be used for heaters, coolers, humidifiers etc.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
name	string	Unique name of the controller	1-1
units	string(enumerated)	KELVIN | CELSIUS | FAHRENHEIT | RELATIVE_HUMIDITY	1-1
setPoint	double	Setpoint value of the controller	1-1
actualValue	double	Actual value of the controller	0-1
zoneType	string(enumerated)	CONVECTIONHEAT | CONDUCTIONHEAT | INFAREDRADIATIONHEAT | COOLING | HUMIDIFIER	0-1
blowerSpeedRPM	nonNegativeInteger	Actual Revolutions per minute (RPM)	0-1
blowerSpeedRate	string(enumerated)	LOW | MEDLOW | MED | MEDHIGH | HIGH	0-1

```
<EnvironmentalControlUnit
      name=”Preheat Lower”
      units=“CELSIUS”
      setPoint=“30.000000”
      actualValue=“30.000000”
      zoneType=”CONDUCTIONHEAT”/>
```

4.4.8 Element: ItemData

Description: This element can be used to generically describe the attributes of an item. This data includes the width and length of the item, the units these elements are being represented in, and the number of parts per item.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
itemMultiplier	nonNegativeInteger	Item Multiplier count of how many parts per item.	0-1
units	String (enumerated)	METER | INCH	0-1
itemLength	double	Length of the item being processed	0-1
itemWidth	double	Width of the item being processed	0-1

```
<ItemData
     itemMultiplier="1"
     units="METER"
     itemLength="0.150"
     itemWidth="0.080"/>
```

4.5 Extensions to IPC-2541 Mandatory Messages

4.5.1 Extensions to <IPC-2541 EquipmentInformation>

4.5.1.7 InformationId: PauseButtonPushed

Description: Information event to indicate that the user is attempting to pause the currently running process program

4.5.1.8 InformationId: ResumeButtonPushed

Description: Information event to indicate that the user is attempting to resume the currently running process program.

4.5.4 Extensions to <IPC-2541 EquipmentAlarms>

4.5.4.1 InformationId: SafetyCoverUnlocked

Description: Information event to indicate that the user unlocked any of the safety covers on the equipment. This is a complement to 5.1.6.1 SafetyCoverOpen already in IPC-2546.

4.5.5 Generic Equipment Extensions to <IPC-2541 EquipmentError>

4.5.5.1 ItemTransportError

Description: This event will be sent whenever there is a problem controlling the transport mechanism. This includes motor problems, timeouts (when items are detected), etc.

```
<EquipmentError
      dateTime="2003-01-23T15:39:23.00+00:00"
      laneList="1"
      zoneList="1"
      errorId="ItemTransportError"
      errorInstanceId="12345">
</EquipmentError>
```

4.5.6 Generic Equipment Extensions to <IPC-2541 EquipmentRecipeSelected>

4.5.6.1 ItemData

Description: This event will be sent whenever a recipe is selected on a piece of equipment.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
ItemData	See 4.4.8	Information about the item	1-1

```
      <Extensions>
            <ItemData
                 itemMultiplier="1"
                 units="METER"
                 itemLength="0.150"
                 itemWidth="0.080"/>
      </Extensions>
```

4.5.7 Generic Equipment Extensions to <IPC-2541 EquipmentRecipeModified>

4.5.7.1 ItemData

Description: This event will be sent whenever a recipe is modified on a piece of equipment.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
ItemData	See 4.4.8	Information about the item	1-1

```
<Extensions>
      <ItemData
           itemMultiplier="1"
           units="METER"
           itemLength="0.150"
           itemWidth="0.080"/>
</Extensions>
```

5 SPECIFIC ASSEMBLY EQUIPMENT EVENTS AND MESSAGE FORMATS

5.1 Specific Screen Printing Equipment Events and Message Formats (Print)

5.2 Specific Adhesive Dispensing Equipment Events and Message Formats (Dispense)

5.2.1 Dictionary of Dispensing Terms

The following is a list of definitions used in dispensing machines including optical methods to verify dispense amounts.

Device Heater

A device, mounted in the conveyor path, that is used to heat a syringe, needle or item, to a specific temperature prior to, during or after the dispense cycle.

Head

The movable assembly that carries the Z-axis components side to side (X) and front to back (Y).

Needle

A hollow tube, usually made of metal or plastic, that is attached to a material supply syringe. The inside diameter of the needle determines the flow rate of the material.

Needle Calibrator

An accessory device that is used to maintain consistent needle distance from the substrate. The calibration utility is used when the needle is changed and/or when Z-axis components are removed and then reinstalled.

Pump

A motor driven device that is used to dispense material at a programmed rate and duration.

Syringe

A hollow plastic cylinder that contains material. Air pressure is used to drive a plunger, which forces material out of the syringe and through a needle.

VerificationLocation

The location where the verification sensor will measure and verify the dispensed material size. This location could be directly on the item itself or a designated area on the dispensing equipment used for all products.

VerificationSensor

The sensor or subsystem used to measure the amount of dispensed material. This is typically the fiducial recognition camera but it may be other devices such as laser-based systems, line scanners and so on.

Weight Scale

A device which is used to measure the weight of a programmed dispense sample. The weight of the sample is compared to a known benchmark. The dispensing parameters are then adjusted accordingly to maintain a constant volume.

Z-Head

The assembly to which the dispense unit or pump and other associated components are attached. The Z-axis controls the height of the dispense unit or pump.

ZSense

A term that describes the act of measuring the height of the substrate, relative to the needle on a dispensing unit or syringe.

5.2.2 Abstract Model of Dispenser Subsystem

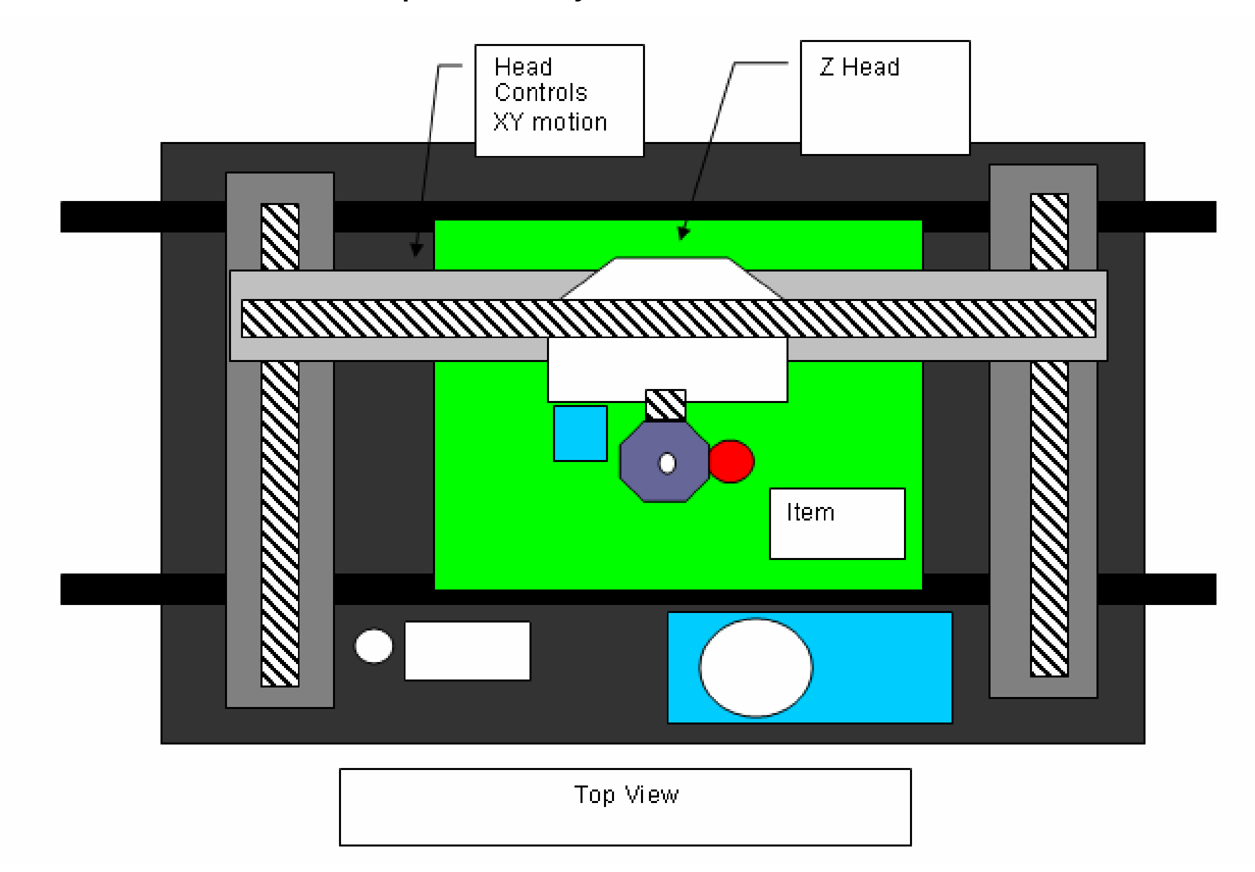


Figure 6 Abstract model of dispenser equipment (top view)

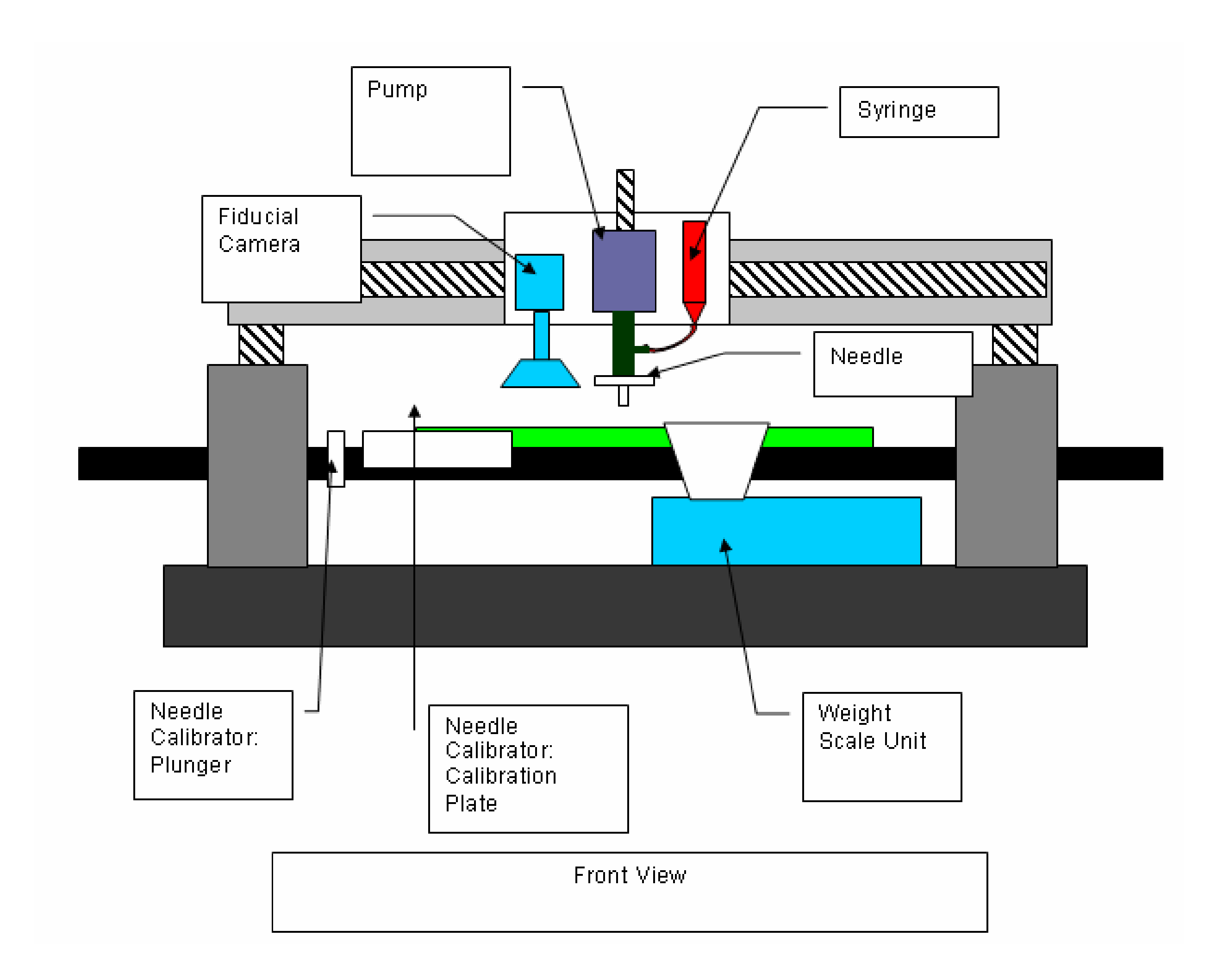
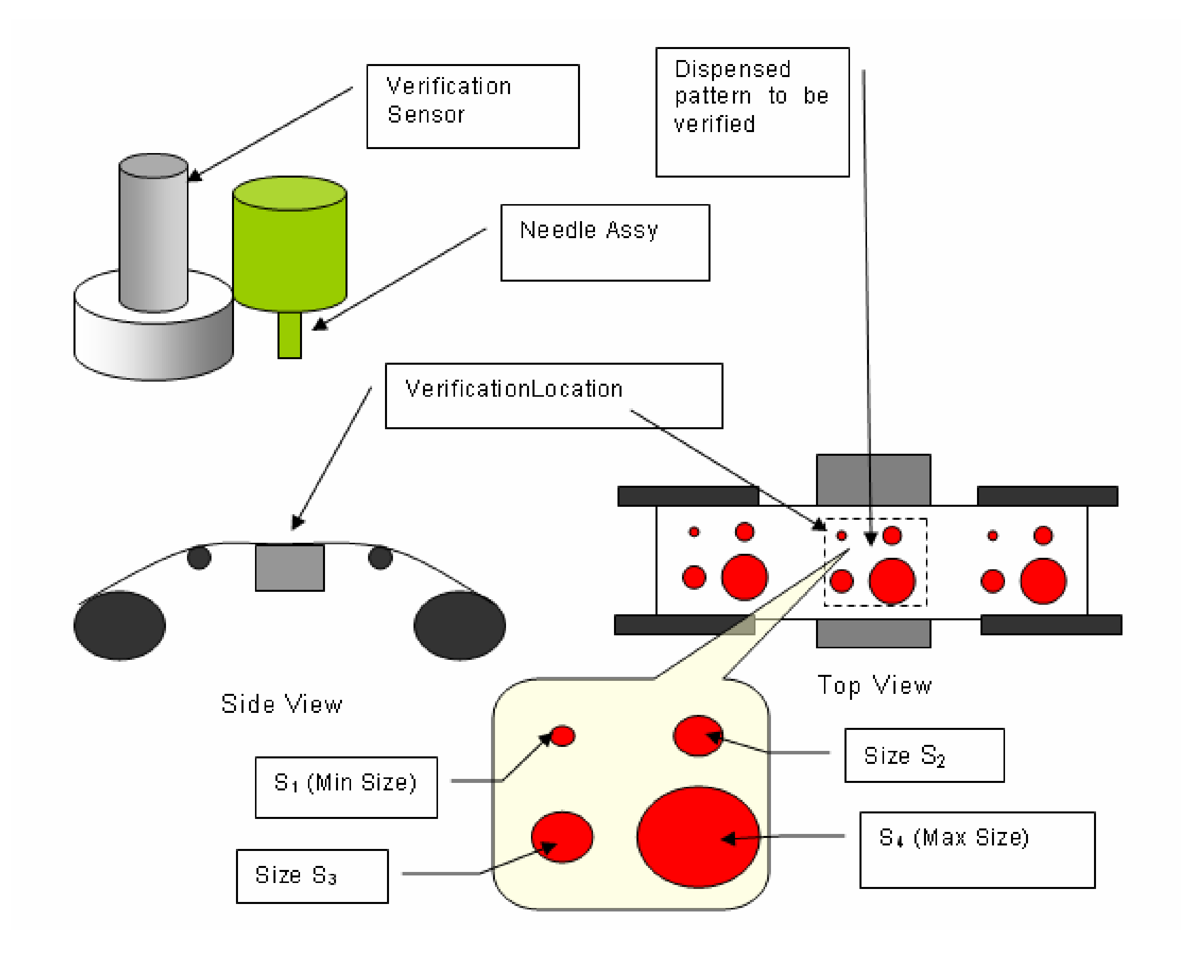


Figure 7 Abstract model of dispenser equipment (front view)

5.2.3 Abstract Model of Dispenser Verification Subsystem



For multiple featured patterns, the verification system will send the machine into an error state (down) when one or more of the following conditions occur:

1. Min Size < PercentToleranceComponent x Max Size
2. ActualValue (sum of S_1 to S_4) < DesiredValue x PercentToleranceTotal after VerificationMaxRetry has been attempted.
3. ActualValue (sum of S_1 to S_4) > DesiredValue x (1+ PercentToleranceTotal) after VerificationMaxRetry has been attempted.
4. The pattern from the verification sensor does not match the pattern described in the VerificationPattern element.

Figure 8 Abstract model of dispenser verification subsystem

5.2.4 Subsystem Types

The subsystem elemement should be used for the subsystem type field. These are “logical” subsystems for dispensing equipment.

Subsystem Type	Attribute Type	Examples / Description
EnvironmentalControl	string	The environmental (heat) control subsystem.
Head	string	The x, y motion subsystem.
Scale	string	The scale subsystem used to measure material.
Transport	string	The item transport subsystem.
Vision	string	The vision system subsystem.

5.2.5 Dictionary of Attributes: Dispensing Verification/Optical Method

The following elements are associated with the optical method used to control or verify the dispensed material amount.

Attribute Name	Attribute Type	Description
verificationLocation	string (enumerated)	ITEM | FIXED
verificationPositionXY	double	The x,y location on the item or from the machine’s reference defining the location of the verification location.
verificationStartCount	nonNegativeInteger	The point at which the verification sensor measures the dispensed material’s size after consecutive dispensing patterns. Example, if set to 3, the first 2 patterns will not be measured, and the first measured material will be on the third pattern.
verificationPattern	string	Describes the dispensed pattern of the particular needle used.
percentTolerance Component	double	Percent allowance of the individual components of a multiple feature dispensed pattern.

5.2.6 Extensions to <IPC-2541 EquipmentInformation>

5.2.6.1 DeviceVerification (weigh or optical system)

Description: There are several ways the amount of material being dispensed can be measured and verified. For all of them the machine takes measurements while running to check the accuracy of the dispense unit. If the amount of material dispensed is not equal to the expected amount plus or minus a tolerance a correction can be applied to adjust for the inaccuracy. This event contains all of the information used for the verification process.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
units	string (enumerated)	OUNCE | KILOGRAM | METER | METER^2 | METER^3 | INCH | INCH^2 | INCH^3	1-1
decade	double	Multiplier used to convert values into the unit type. Unit multiplier in powers of 10. Default is 0.	1-1
desiredValue	double	Target value for each verification	1-1
actualValue	double	Actual measured value	1-1
percentToleranceTotal	double	Acceptable total tolerance	1-1
scaleFactor	double	Multiplier used to adjust dispensed material to get to the desired value.	1-1
attemptNumber	nonNegativeInteger	Attempt number: 1, 2 or 3	1-1

maxAttempts	nonNegativeInteger	The maximum number of attempts that are allowed before a verification error occurs.	0-1
verificationLocation	string (enumerated)	ITEM | FIXED	0-1
verificationPositionXY	double	The x,y coordinates on the item or from the machine's reference defining the location of the verification location.	0-1
verificationStartCount	nonNegativeInteger	The point at which the verification sensor measures the dispensed material's size after consecutive dispensing patterns. Example, if set to 3, the first 2 patterns will not be measured, and the first measured material will be on the third pattern.	0-1
dispenseVerification RecipeId	string	Name of the recipe used to define the verification parameters	0-1
percentTolerance Component	double	Acceptable tolerance for the individual features in the dispensed pattern.	0-1
verficationPattern	string	Type of pattern used. Items like SINGLE DOT, TWO DOT, FOUR DOT.	0-1

```
<EquipmentInformation
      dateTime="2003-01-23T15:39:23.00+00:00"
      laneList="1"
      zoneList="1"
      informationId="DispenseVerification">
      <Extensions>
         <DispenseVerification
            units=”KILOGRAM”
            decade=”-6”
            desiredValue="880.000000"
            actualValue="861.299988"
            percentToleranceTotal="10.000000"
            scaleFactor="1.000000"
            attemptNum="1"
            maxAttempts=”3”
            dispenseVerificationRecipeId="C:\Verification880mg"
            percentToleranceComponent =”25.000000”
            verificationPattern=”TWO DOT”
            />
      </Extensions>
</EquipmentInformation>
```

5.2.6.2 DispenserDataUpdate

Description: This event will be sent on a periodic basis from the equipment to notify the host of the current temperature values for all of the temperature controllers in the system. The host can use this data to track the temperatures of the devices at the time a given board was traveling through the equipment.

Note: This message will be sent on a user-settable time interval.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
updateRate	nonNegativeInteger	Frequency this message is sent. Time is in seconds.	0-1
EnvironmentalControlUnit	See 4.4.7	A specific instance of an ECU and it associated data.	1-n

```
<EquipmentInformation
      dateTime="2003-01-23T15:39:23.00+00:00"
      laneList=""
      zoneList=""
      informationId="DispenserDataUpdate">
      <Extensions>
            <DispenserDataUpdate
                  updateRate=”60”>
                  <EnvironmentalControlUnit
                        name=”Preheat Lower”
                        units=“CELSIUS”
                        actualValue=“30.000000”
                        setPoint=“30.000000”/>
                  <EnvironmentalControlUnit
                        name=”Dispense”
                        units=“CELSIUS”
                        actualValue=“30.000000”
                        setPoint=“30.000000”/>
                  <EnvironmentalControlUnit
                        name=”Postheat Lower”
                        units=“CELSIUS”
                        actualValue=“30.000000”
                        setPoint=“30.000000”/>
            </DispenserDataUpdate>
      </Extensions>
</EquipmentInformation>
```

5.2.6.3 DispenserConfiguration

Description: This event will be sent at startup to tell the host the options that a given piece of equipment has installed. It is assumed that not every piece of equipment has the same options. The host can then use this data to determine how or what to display. For instance, if the machine has multiple lanes the host could show additional material movement tracking information for every lane in the system. Or if the machine only had a single lane the host could hide the lane data for all but the one lane.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
laneCount	nonNegativeInteger	Number of lanes in the machine	1-1
zoneCount	nonNegativeInteger	Number of zones/lane in the machine	1-1
conveyorDirection	string (enumerated)	LEFTTORIGHT | RIGHTTOLEFT | LEFTTOLEFT | RIGHTTORIGHT	1-1
dispenseVerification	string (enumerated)	NONE | WEIGH | OPTICAL	1-1
EnvironmentalControl Unit	See 4.4.7	A specific instance of an ECU and it associated data.	1-n

```
<EquipmentInformation
      dateTime="2003-01-23T15:39:23.00+00:00"
      laneList=""
      zoneList=""
      informationId=" DispenserConfiguration">
      <Extensions>
            <DispenserConfiguration
                  laneCount="1"
                  zoneCount="3"
                  conveyorDirection="LEFTTORIGHT"
                  dispenseVerification="WEIGH">
                  <EnvironmentalControlUnit
```

```
                        name=”Preheat Lower”
                        units=“CELSIUS”
                        actualValue=“30.000000”
                        setPoint=“30.000000”/>
                  <EnvironmentalControlUnit
                        name=“Dispense”
                        units=“CELSIUS”
                        actualValue=“30.000000”
                        setPoint=“30.000000”/>
                  <EnvironmentalControlUnit
                        name=“Postheat”
                        units=“CELSIUS”
                        actualValue=“30.000000”
                        setPoint=“30.000000”/>
                  <EnvironmentalControlUnit
                        name=“Dispense Zhead 1”
                        units=“CELSIUS”
                        actualValue=“30.000000”
                        setPoint=“30.000000”/>
                  <EnvironmentalControlUnit
                        name=“Dispense Zhead 2”
                        units=“CELSIUS”
                        actualValue=“30.000000”
                        setPoint=“30.000000”/>
            </DispenserConfiguration>
      </Extensions>
</EquipmentInformation>
```

5.2.7 Dispenser Specific IPC-2541 EquipmentError

5.2.7.1 HeadError

Description: This event will be sent whenever there is an error with a given head. The error can be with the X, Y or Z motion.

```
<EquipmentError
      dateTime="2003-01-23T15:39:23.00+00:00"
      laneList="1"
      zoneList="1"
      errorId="HeadError"
      errorInstanceId="12345">
      <Extensions>
            <MachineError
                  vendorErrorCode=”44231”
                  description=”CoordinateSystemStatus”>
                  <Subsystem
                        subsystemType=”Head”
                        subsystemId=”Head 1: Needle 1”
                  />
            </MachineError>
      </Extensions>
</EquipmentError>
```

5.2.7.2 DispenseVerificationError

Description: This event will be sent whenever there is an error with the dispense verification system.

```
<EquipmentError
      dateTime="2003-01-23T15:39:23.00+00:00"
      laneList="1"
```

```
        zoneList="1"
        errorId="DispenseVerificationError"
        errorInstanceId="12345">
        <Extensions>
              <MachineError
                    vendorErrorCode=”23421”
                    description=”FailedToConverge”>
                    <Subsystem
                          subsystemType=”Scale”
                          subsystemId=”Head 1: Needle 1”
                    />
              </MachineError>
        </Extensions>
</EquipmentError>
```

5.2.7.3 ZSenseError

Description: This event will be sent whenever there is a problem with the Zsense device. Zsense’s are used to determine the actual height of a board in the machine. A Zsense can be a probe or a laser.

```
<EquipmentError
        dateTime="2003-01-23T15:39:23.00+00:00"
        laneList="1"
        zoneList="1"
        errorId="ZSenseError"
        errorInstanceId="12345">
        <Extensions>
              <MachineError
                    vendorErrorCode=”21266”
                    description=”OutOfRange”>
                    <Subsystem
                          subsystemType=”Head”
                          subsystemId=”Head 1”/>
              </MachineError>
        </Extensions>
</EquipmentError>
```

5.2.7.4 PumpError

Description: This event will be sent whenever there is a problem with a pump, e.g. torque limit error on the pump.

```
<EquipmentError
        dateTime="2003-01-23T15:39:23.00+00:00"
        laneList="1"
        zoneList="1"
        errorId="PumpError"
        errorInstanceId="12345">
        <Extensions>
              <MachineError
                    vendorErrorCode=”57231”
                    description=”TorqueLimit”>
                    <Subsystem
                          subsystemType=”Head”
                          subsystemId=”Head 1: Needle 1”/>
              </MachineError>
        </Extensions>
</EquipmentError>
```

5.2.7.5 EnvironmentalControlUnitError

Description: This event will be sent whenever there is a problem with an environmental control unit, e.g. an out of range error.

```
<EquipmentError
       dateTime="2003-01-23T15:39:23.00+00:00"
       laneList="1"
       zoneList="1"
       errorId="EnvironmentalControlUnitError"
       errorInstanceId="12345">
       <Extensions>
              <MachineError
                     vendorErrorCode="44255"
                     description="OutOfRange">
                     <Subsystem
                            subsystemType="EnvironmentalControl"
                            subsystemId="Controller 1: DispenseChuck"/>
              </MachineError>
       </Extensions>
</EquipmentError>
```

5.3 Specific Manual Placement Equipment Events and Message Formats (Manual)

Under consideration

5.4 Specific Reflow Equipment Events and Message Formats (Reflow)

5.4.1 Dictionary of Reflow Terms

The objective of this model is to define a common naming convention for the subsystem categories used in reflow machines.

Actual

In terms of process control variables, the value of the present, real time reading of a parameter read through some type of sensing device. This value is often compared to the setpoint value.

Additional Cooling

Term used to describe an optional cooling module or zone within the machine. Independent data may or may not be collected from this module.

Automatic Width Adjust

A mechanism used to automatically control the width of a rail transport or center board support through the integrated control system.

Belt Transport

A term used to describe mesh belt type systems used to convey the product through the machine. Typically, the item travels directly on top of the transport. Belt transports are fixed width transports.

Center Board Support

A support mechanism used in conjunction with the transport to prevent item warpage and/or sagging while conveying the product through the oven. Used in conjunction with a rail or some equivalent form of edge holding transport system to support an otherwise unsupported portion of

the item. A system could potentially have more than one Center Board Support per rail transport and/or lane.

Center Board Support Up Position

Center Board Support is at its width setting and fully extended in an upward position as to properly support the item while conveying it through the system.

Center Board Support Down Position

Center Board Support is at its width setting, but in a downward position so as to provide clearance for the item to convey through the system without support.

Center Board Support Park Position

Center Board Support is at a predefined “home” position where it allows the unsupported conveyance of items without impeding on lead clearance.

Center Board Support Width

The distance of the support mechanism from some reference position, usually a fixed rail, defines the width parameter

Combination Transport

A term used to describe a transport system that uses a rail transport with a belt transport in the same lane.

Cooling Zone

Used in reference to the final section of the reflow process, it refers to the portion of the oven that gradually cools the processed item and solidifies the solder joints. Temperature in these zones may or may not be controlled.

Dual Lane Transport

A transport system with two independent rail lanes/tracks. See Rail Transport.

Dual Lane, Single Belt Transport

A transport system with two independent rail lanes/tracks with a single mesh belt transport, spanning both lanes, traveling below the rails.

Flux Extraction

A subsystem of a reflow oven used to capture, collect, or otherwise eliminate flux volatiles released into the chamber atmosphere during the reflow process.

Heated Zone

A zone that provides a unique set of control or display parameters for purposes of heating the item. Heated zones can utilize infrared radiation, convection, conduction, or any combination thereof. Usually used in reference to the first three stages within the reflow process (ramp, soak, spike/reflow). Temperature in these zones is usually controlled to a specific temperature.

Inert Gas

In terms of the reflow process, the inert gas, most commonly nitrogen (N2), displaces oxygen within the reflow chamber, allowing better soldering properties and results. Often referred to in terms of an allowable concentration of oxygen in parts per million (PPM). In the absence of an inert gas, the environment is simply referred to as an “air” environment.

Pin Chain Transport

See Rail Transport

Rail Transport

A conveying system that provides two rails along the length of the machine, each supporting one edge of an item. This is accomplished through the use of a support system traveling within the rail. The most common type of support is a pin chain that travels within a groove in the rail; therefore, this type of system is often referred to as a “pin chain” transport. Several independent rail transports can be configured within a single oven. Two sets of rail transports within the same system are known as “Dual Lane” transports. Three sets of rails within the same system are known as “Triple Lane” transports. Each track or “lane” can be dependently or independently controlled in terms of width and speed. The physical distance between the two rails defines the transport width. Each “lane” can potentially support multiple center board supports if needed.

Reflow

A term used to describe the melting of previously placed solder. For example, it applies to the fusing of electroplated tin–lead coatings on printed circuit boards through infrared, conductive, or convection type heating.

Setpoint

The process control value for which the specified controller is attempting to maintain. This value is often compared to the actual value.

SMEMA

In terms of reflow oven terminology, refers to the electrical interface/communication system used to convey critical item transport data to and from upstream/downstream transport systems. Refer to SMEMA standard for further explanation.

Transport Direction

The direction of product travel through the oven. Usually a right-to-left or left-to-right direction.

Triple Lane Transport

A transport system with three independent rail lanes/tracks. See Rail Transport.

5.4.2 Abstract Model of Reflow Subsystems

5.4.2.1 Examples of Transport Types

As described in previous sections, transport systems within reflow ovens can become fairly complex. In terms of identifying the common terminology used throughout this standard, please refer to the diagrams shown in Figures 9 through 11. These figures show a representative sample, from an end view, of a rail, belt, dual lane, and center board support transport systems.

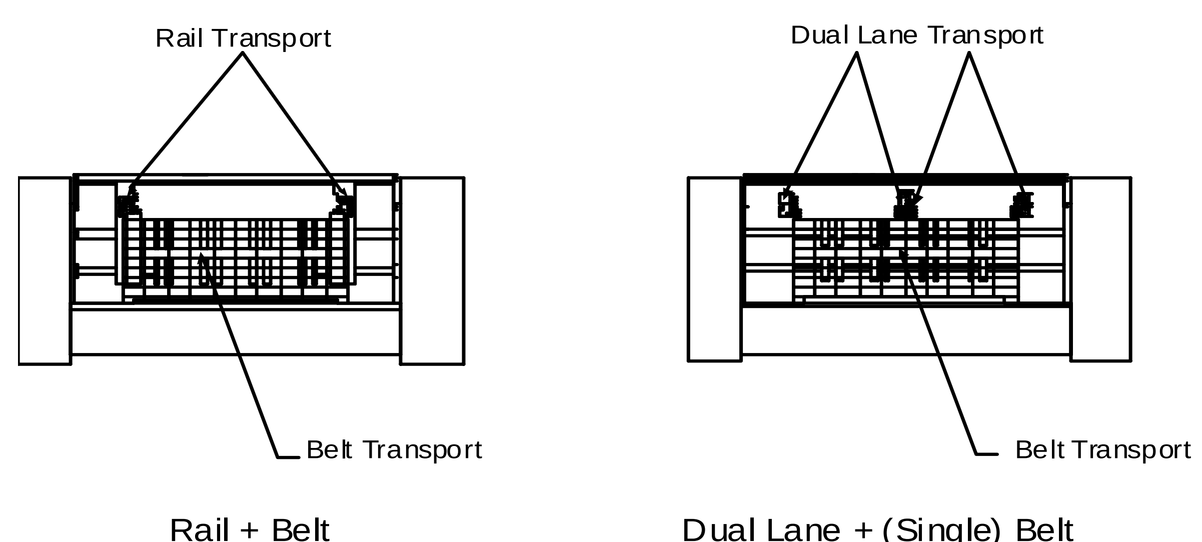


Figure 9 Combination Transport

Figure 10 Dual Lane, Single Belt Transport

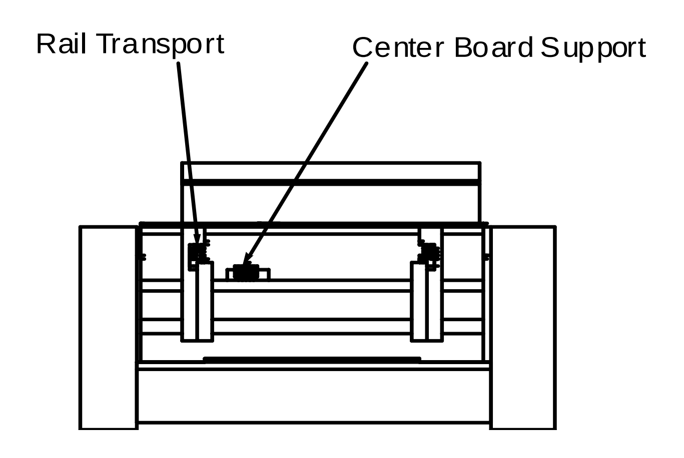


Figure 11 Center Board Support

5.4.2.2 Examples of Zone descriptions

A “zone” within a reflow oven can take on many different meanings. Simply stated, it can be described as a physical section within the chamber, which maintains its own unique control and/or display parameters. It could be referred to as heated, cooling, spike, reflow, ramp, soak, or other specific indicator (i.e., top 10, bottom 5, etc.) based on the construction and independent control/display capabilities within the design of the oven. The overall number of zones may vary per manufacturer and/or oven type. Examples of some common zone descriptions are shown in Figures 12 and 13.

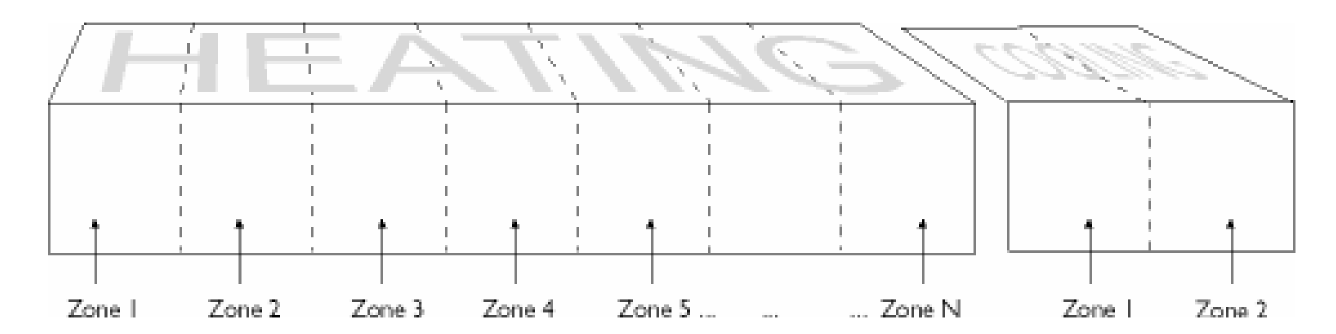


Figure 12 Example of Zone Description

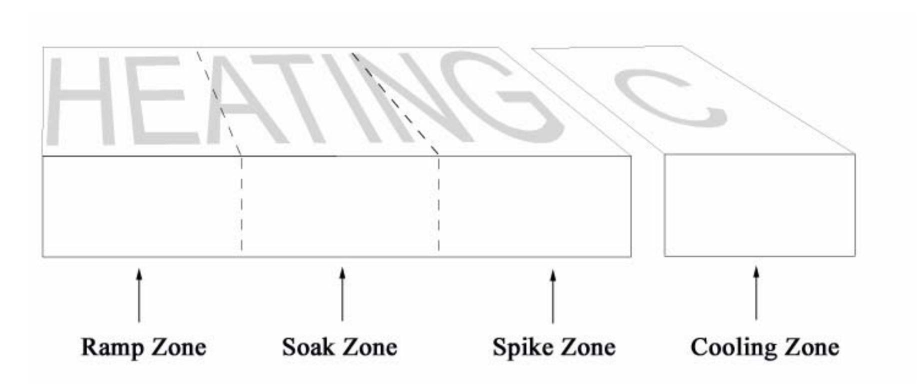


Figure 13 Example of Zone Description

5.4.3 Reflow-Specific Nested Elements

5.4.3.1 Element: InertGasController

Description: This element is used to describe an inert gas controller (specifically air or nitrogen).

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
name	string	Unique name of the controller (i.e., zone 10 PPM, cooling PPM, etc.)	0-1
type	string (enumerated)	AIR | NITROGEN	0-1
setPointPPM	nonNegativeInteger	Setpoint PPM (parts per million)	0-1
actualPPM	nonNegativeInteger	Actual PPM (parts per million) value	0-1
flowUnits	string (enumerated)	FEET^3/SECOND | METER^3/SECOND (zone specific)	0-1
decade	double	Multiplier used to convert values into the unit type. Unit multiplier in powers of 10. Default is 0.	0-1
flow	double	Total Consumption in specified Inert Gas flow units (zone specific)	0-1

```
<InertGasController
   name=”Zone10 PPM”
   type=”NITROGEN”
   setPoint=”550”
   actualPPM=”555”
   flowUnits=”FEET^3/SECOND”
   decade=”-3.556302501”
   flow=”540”/>
```

5.4.3.2 Element: TransportData

Description: This element is used to describe the characteristics of the item transport device

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
name	string	Unique name of the transport (i.e. transport 1, transport 2 w/Center Board Support, Rail 1, Rail 1 w/dual Center Board Support, etc…)	1-1
laneId	string	Line lane identifier	1-1
units	string (enumerated)	METER | INCH	1-1
decade	double	Multiplier used to convert values into the unit type. Unit multiplier in powers of 10. Default is 0.	1-1
speed	nonNegativeInteger	Actual Transport Speed in units/second	1-1
width	nonNegativeInteger	Transport Width in units	0-1
centerBoard Support1Position	string (enumerated)	UP|DOWN|PARK	0-1
centerBoard Support1Width	double	Position of center board support (in transport units)	0-1
centerBoard Support2Position	string (enumerated)	UP|DOWN|PARK	0-1
centerBoard Support2Width	double	Position of center board support (in transport units)	0-1

```
<TransportData
   name=”Rail 1”
   units=”METER”
   speed=”44”
   width=”10”
   decade=”-2”
   centerBoardSupport1Position=”UP”
   centerBoardSupport1Width=”5”
   centerBoardSupport2Position=”UP”
   centerBoardSupport2Width=”5”/>
```

5.4.4 Extensions to <IPC-2541 EquipmentError> Messages

5.4.4.1 SystemGasLowPressure

Description: This event will be sent whenever the air/nitrogen pressure in the system is below an acceptable value.

```
<EquipmentError
      dateTime="2003-01-23T15:39:23.00+00:00"
      laneList="1"
      zoneList="1"
      errorId="SystemGasLowPressure"
```

```
      errorInstanceId="12345">
</EquipmentError>
```

5.4.5 Extensions to <IPC-2541 EquipmentInformation>

5.4.5.1 ReflowDataUpdate

Description: This event will be sent on a periodic basis from the equipment to notify the host of the current values of items in the machine that change as the machine runs. For instance the current temperatures of all of the temperature controllers in the system. The host can use this data to track the temperatures of the devices at the time a given board was traveling through the equipment.

Note: This message will be sent on a user settable time interval.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
updateRate	nonNegativeInteger	Frequency this message is sent. Time is in seconds.	0-1
itemsInMachine	nonNegativeInteger	Total Number of items	1-1
inertGasOn	boolean	true, false (not used with air)	0-1
fluxExtraction	boolean	true (if Enabled), false	0-1
EnvironmenalControlUnit	See 4.4.7	A specific instance of an ECU and it associated data.	1-n
TransportData	See 5.4.3.2	A specific instance of transport data	1-n
InertGasController	See 5.4.3.1	A specific instance of an inert gas controller and data	0-n

```
<EquipmentInformation
      dateTime="2003-01-23T15:39:23.00+00:00"
      laneList=""
      zoneList=""
      informationId="ReflowDataUpdate">
      <Extensions>
            <ReflowDataUpdate
                  updateRate=”60”
                  itemsInMachine=”4”
                  inertGasOn="true"
                  fluxExtraction=”true”>
                  <EnvironmentalControlUnit
                        name=”Zone1 Upper”
                        units=“CELSIUS”
                        actualValue=“30.000000”
                        setPoint=“30.000000”
                        zoneType=”CONVECTION”
                        blowerSpeedRate=”MEDHIGH”/>
                  <EnvironmentalControlUnit
                        name=”Zone1 Lower”
                        units=“CELSIUS”
                        actualValue=“30.000000”
                        setPoint=“30.000000”
                        zoneType=”CONVECTION”
                        blowerSpeedRate=”MEDHIGH”/>
                  <EnvironmentalControlUnit
                        name=“Zone2 Upper”
                        units=“CELSIUS”
```

```
                        actualValue=“30.000000”
                        setPoint=“30.000000”
                        zoneType=”CONVECTION”
                        blowerSpeedRate=”MEDHIGH”/>
                  <EnvironmentalControlUnit
                        name=“Zone2 Lower”
                        units=“CELSIUS”
                        actualValue=“30.000000”
                        setPoint=“30.000000”
                        zoneType=”CONVECTION”
                        blowerSpeedRate=”MEDHIGH”/>
                  <EnvironmentalControlUnit
                        name=“Zone3 Upper”
                        units=“CELSIUS”
                        actualValue=“30.000000”
                        setPoint=“30.000000”
                        zoneType=”CONVECTION”
                        blowerSpeedRate=”MEDHIGH”/>
                        .
                        .
                        .
                  <EnvironmentalControlUnit
                        name=“Zone N”
                        units=“CELSIUS”
                        actualValue=“30.000000”
                        setPoint=“30.000000”
                        zoneType=”CONVECTION”
                        blowerSpeedRate=”MEDHIGH”/>
                  <InertGasController
                        name=”Zone10 PPM”
                        type=”NITROGEN”
                        setPoint=”550”
                        actualPPM=”555”
                        flowUnits=”FEET^3/SECOND”
                        decade=”-3.556302501”
                        flow=”540”/>
                  <TransportData
                        name=”Rail 1”
                        units=”METER”
                        speed=”44”
                        width=”10”
                        decade=”-2”
                        centerBoardSupport1Position=”UP”
                        centerBoardSupport1Width=”5”
                        centerBoardSupport2Position=”UP”
                        centerBoardSupport2Width=”5”/>
            </ReflowDataUpdate>
      </Extensions>
</EquipmentInformation>
```


5.4.5.2 ReflowConfiguration

Description: This event will be sent at startup to tell the host the options that a given piece of equipment has installed. It is assumed that not every piece of equipment has the same options. The host can then use this data to determine how or what to display. For instance if the machine has multiple lanes the host could show additional material movement tracking information for every lane in the system. Or if the machine only had a single lane the host could hide the lane data for all but the one lane.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
laneCount	nonNegativeInteger	Number of lanes in the machine	1-1
zoneCount	nonNegativeInteger	Number of zones per lane in the machine	1-1
transportDirection	string (enumerated)	LEFTTORIGHT | RIGHTTOLEFT | LEFTTOLEFT | RIGHTTORIGHT	1-1
highTemp	boolean	true (if Installed), false	1-1
gasType	string (enumerated)	NITROGEN | AIR	1-1
additionalCooling	boolean	true (if Installed), false	1-1
fluxExtraction	boolean	true (if Installed), false	1-1
transportType	string (enumerated)	BELT | RAIL | COMBINATION | DUALLANE | DUALLANESINGLEBELT | TRIPLELANE	1-1
autoWidthAdjust	boolean	true (if Installed), false	1-1
smema	boolean	true (if Installed and enabled), false	1-1
centerBoardSupport	boolean	true (if Installed and enabled), false	1-1

```
<EquipmentInformation
      dateTime="2003-01-23T15:39:23.00+00:00"
      laneList=""
      zoneList=""
      informationId="ReflowConfiguration">
      <Extensions>
            <ReflowConfiguration
                  laneCount="1"
                  zoneCount="8"
                  transportDirection="LEFTTORIGHT"
                  highTemp="true"
                  gasType="NITROGEN"
                  additionalCooling="true"
                  fluxExtraction="true"
                  transportType="BELT"
                  autoWidthAdjust="true"
                  smema="true"
                  centerBoardSupport=”false”/>
      </Extensions>
</EquipmentInformation>
```

5.9 Final Assembly and Packaging

This section pertains to final assembly and packaging equipment. This primarily includes assembly, marking and automated packaging as well as material movements modules, routers and similar equipment.

5.9.1 Instructions

All elements and extensions presented in Section 5.9 are defined in separate XML namespace. URI is webstds.ipc.org/2546/fa/*.xsd.

NOTE: There exist different definitions for some elements with same name but different content located in other namespaces. See 5.9.5.12 *Parameter* as example.

5.9.2 Dictionary of Common Terms

Assembly Operation (or assembly primitive)

A single action changing one state of the targeted object (product, product's part, tool, etc.) Examples: Translation, Rotation

Assembly Processes

A series of actions or operations associated with the assembly of parts. Examples: Inserting, screw insertion, tray feeding, vibratory feeding

Assembly Task

A set of assembly processes for the performing of similar assembly functions.
Examples: Composing (or joining), Grasping, Fixturing, Releasing

Container

A unit housing one or more products or components. A container can also house one or more containers.
Examples: Pallet, Carton/Box, Tray.

Container Position

A specific location on or in a container.

Depaneling (also Routing, Separating or Singulating) process

The process of separating product or component PWBs from each other or from a PWB frame that consists of one or several PWBs.

End Effector

An End Effector consists of an End Effector Base and End Effector Tool(s). End Effector is used for processing or handling an item.
Examples: Gripper, Soldering Head, Screwdriver.

End Effector Base

A base unit of End Effector. Both base and End Effector can be changeable or fixed.

End Effector Group

An End Effector Group holds one or more End Effectors that are moved together in the equipment.
Example: Revolver Tool.

End Effector Tool

A part of an End Effector that interacts with an item like a component or a product. It can be a changeable part of an End Effector.
Examples: Finger, Suction Head, Soldering Iron, Screw Insertion Tool, Sensor

End Effector Tool Storage

A holding bin for End Effector Tools. This is a physical location on the equipment.

End Effector Tool Storage Location

A location within the End Effector Tool Storage that can hold End Effector Tool(s) not currently in operation.

End Effector Segment

A fixed location of an (changeable) End Effector Base that can have one (changeable) End Effector Tool.

End Effector Storage

A holding bin for End Effectors. This is a physical location on the equipment.

End Effector Storage Location

A location within the End Effector Storage that can hold End Effector(s) not currently in operation.

Feeder

A material handler, that feeds the end effector with components out of tapes or bulk cases. Examples: Tape, bowl or tray feeder, label printer.

Feeder Division

A unique location within a feeder.

Feeder Track

A unique location of the feeder in a component supply area

FeederId

A unique identification number associated with a feeder.

Final Assembly

Actions applied to the product after the PWB is finalized. Beginning with the depaneling of the PWB, assembly of subcomponents and the product itself, ending with the finalized product.

Gripper

A specific type of an End Effector.

Identifier Tag

A medium where identification information about a container can be stored.
Examples: Bar Code, RF tag

Material Handler

A device to supply the equipment with material (e.g. components) that have to be placed. This is a term that should cover all existing technologies like feeders, printers or matrix tray changer.

Material Supply Area

A unique area of material supplies found on the equipment.
Examples: Right, Left, Front, Back.

PCB

Printed Circuit Board. In this document this term is replaced with PWB.

PWB

Printed Wiring Board. This acronym will be used when referring to a Printed Circuit Board.

Packaging

Places the finalized product into an intermediate or a retail package. This includes typically the product, accessories and manuals.

Pallet

A specific type of container whose primary use is for transporting products. It can also contain components. It is recommended that the term *pallet* be used for containers that contain product(s) and transfer them within the production flow rather than in and out of the process.

Process Step

Process steps are sub-processes of equipment work cycle. e.g. Transportation, screwdriving, welding, milling.

Tray

A specific type of container that is used for storing and/or delivering components or products. It is recommended that the term *tray* be used for containers that transfer components in and out of the process rather than within the production flow.

Tray Feeder

A tray feeder is a specific type of feeder that holds trays and supplies them to the equipment

Tray Location

The location of a tray in a tray feeder.

Tray Section

The area of a tray containing one type of item (component, product). A tray may contain one or more tray sections. The sections may be of different sizes and shapes.

5.9.3 Model of Equipment

A model of typical final assembly cell is shown in Figure 14. The model consists of two pieces of equipment: an assembly cell and a container transporter. The assembly area for the assembly cell is in location: Lane2, Zone2.

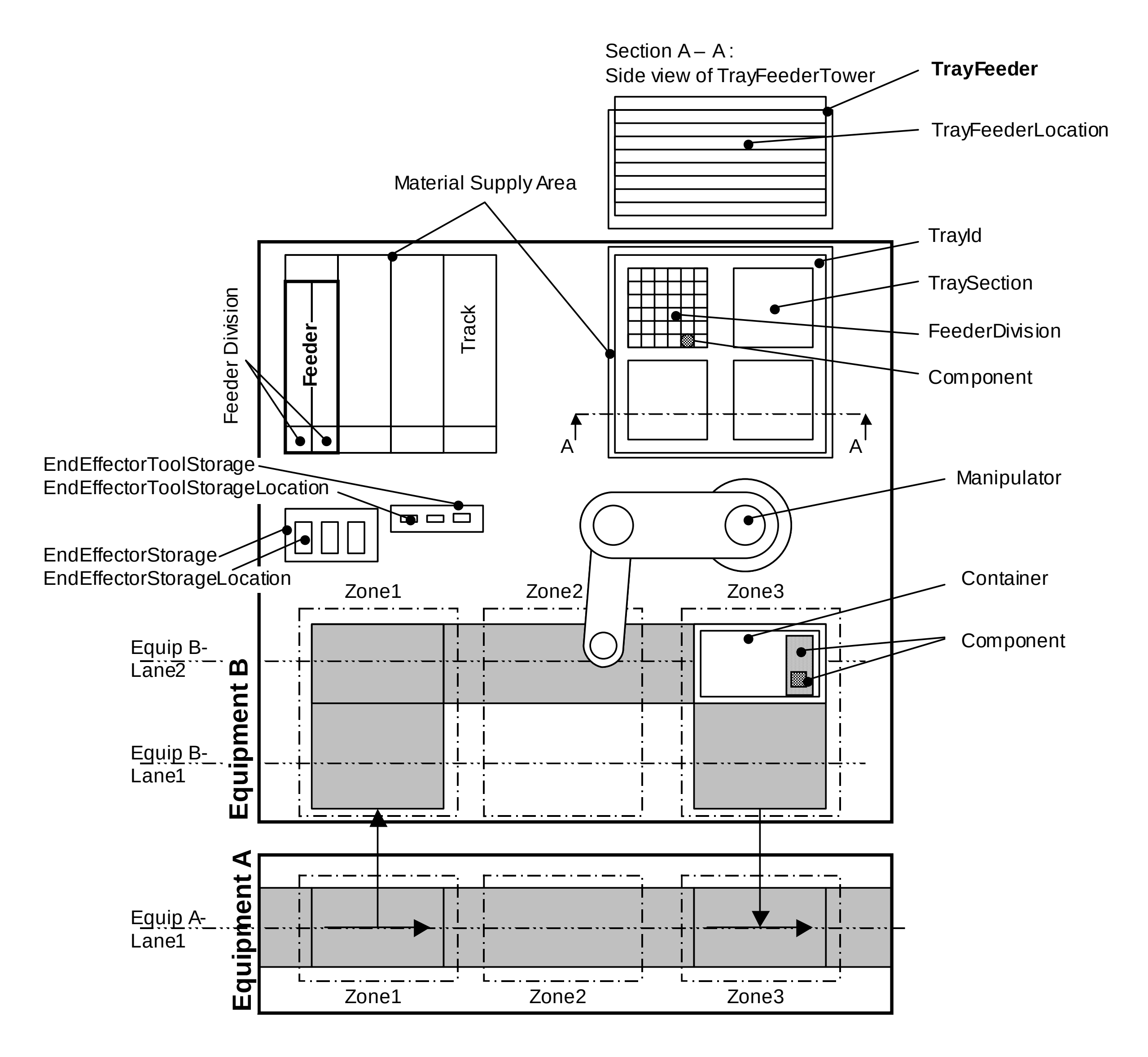


Figure 14 Abstract Model of Assembly Cell (=Equipment B) and Transporter module (=Equipment A)

Few models of changeable End Effectors are shown in Figure 15.

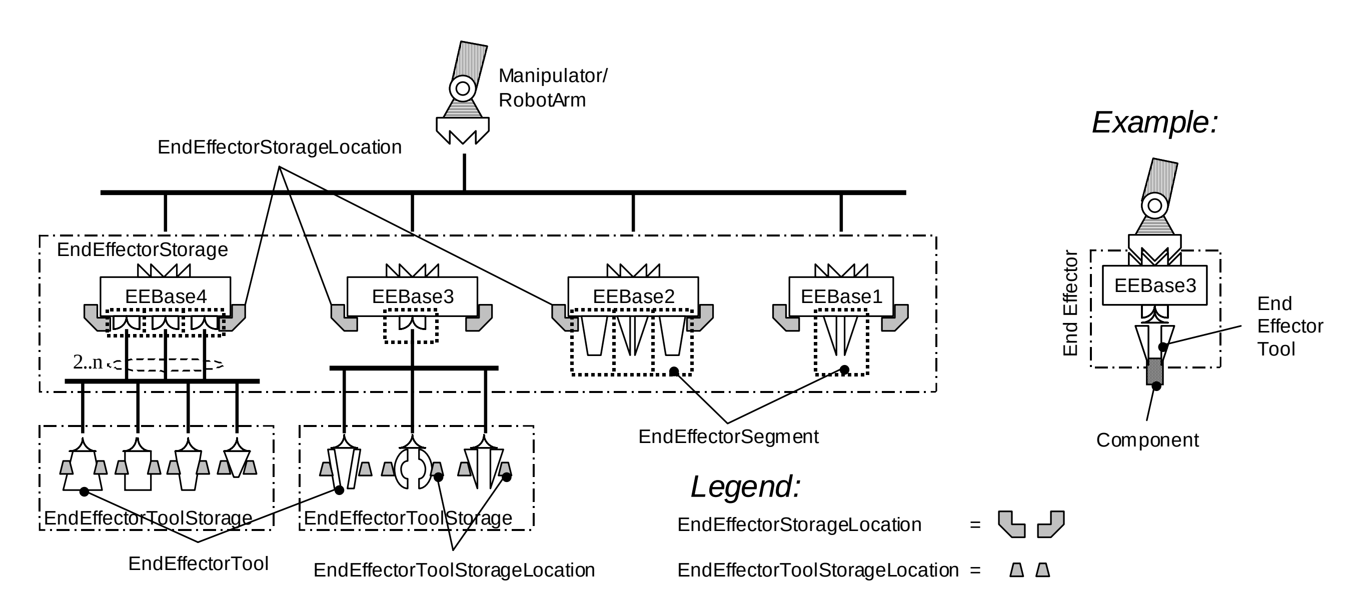


Figure 15 Abstract model of End Effectors

Example cases of changeable End Effector Bases and explanation of Figure 15:

- **EEBase1**: Simplest possible changeable end effector that has one End Effector Segment, which has one fixed End Effector Tool attached.

  Example: a pneumatic gripper with fingers.

- **EEBase2**: End Effector that has several fixed End Effector Tools attached into the End Effector Base. End Effector Base has End Effector Segments that identifies, which End Effector Tool is attached into this segment.

  Example: a revolver gripper that has two or more End Effector Segments with fixed fingers.

- **EEBase3**: End effector that has a single End Effector Segment for carrying changeable End Effector Tool.

  Example: a multi finger servo gripper (entity has pair of fingers)

- **EEBase4**: End effector that has several locations for carrying changeable End Effector Tools. End Effector Base has two or more End Effector Segments that identifies the End Effector Tool placed into this specific segment.

  Example: a revolver gripper that has two or more End Effector Segments with changeable End Effector Tools.

Figure 16 describes possible relationships between objects in abstract FA&P equipment model.

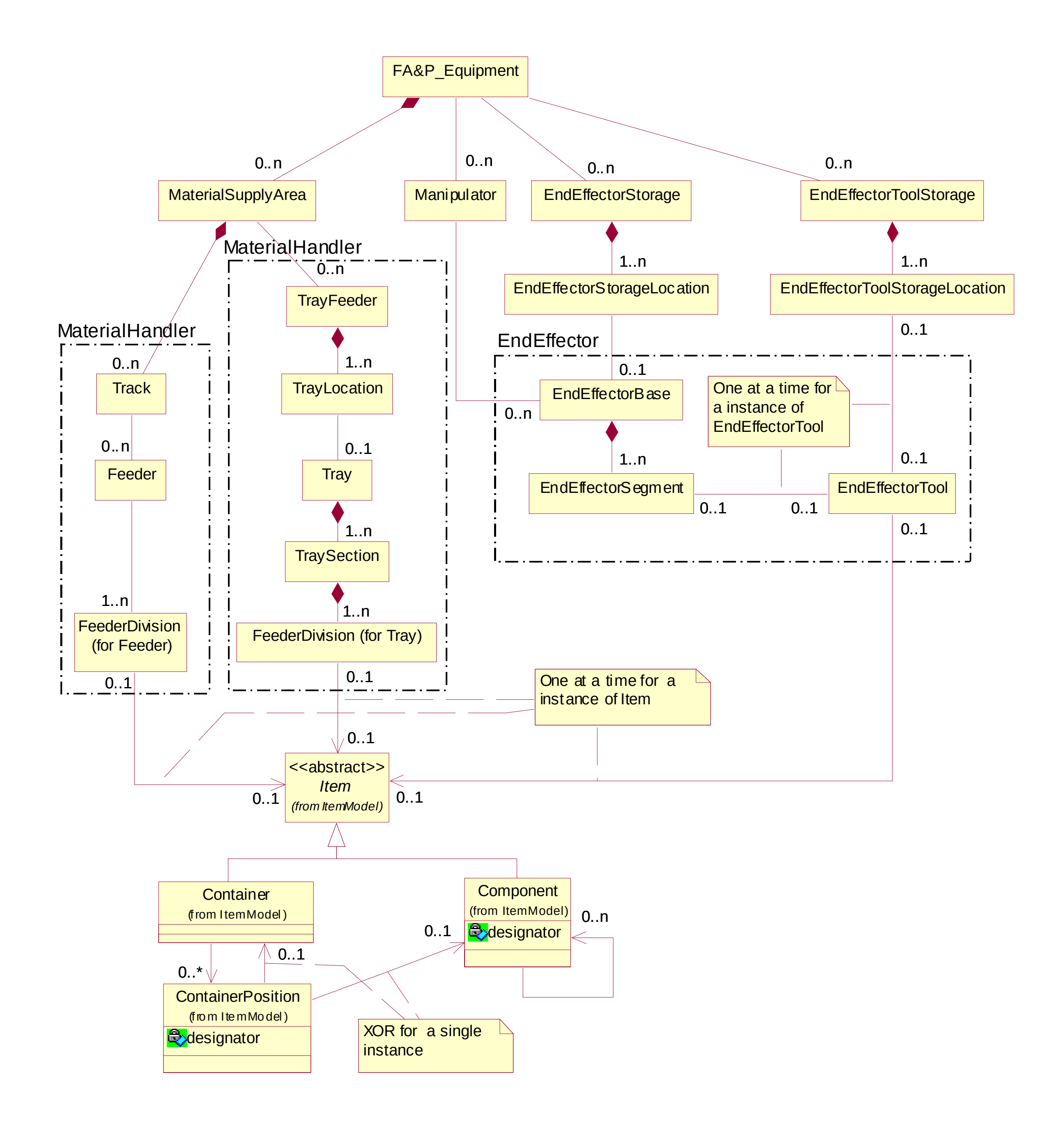


Figure 16 Abstract FA&P equipment and item model, object relationships

Explanations:

- End Effector Base belongs always to one End Effector Location, either to one in Manipulator or End Effector Storage. For a very short moment it can belong to both. This can happen when manipulator is gripping or releasing the End Effector Base from/to End Effector Storage.

- End Effector Tool belongs to either End Effector Segment or End Effector ToolStorage Location. For same reason as End Effector Base the End Effector Tool may for a short moment belong to both.
- Manipulator usually has only one End Effector Location, but e.g. in case of revolver head it can have two or more locations for End Effectors.

5.9.4 Dictionary of Final Assembly and Packaging Specific Attributes and Parameters

5.9.4.1 Dictionary of Final Assembly and Packaging Attributes

Attribute Name	Attribute Type	Description
abortId	string	Abort identifier
actionType	string (enumerated)	Type of modify action: CREATE | ATTACH | DETACH
amount	integer	Amount of components filled into (>0) or taken away from (<0) the material handler. (* check: changeType
application	string (enumerated)	The type of the element MEASURED | EXPECTED | ALARMLIMITS
caseSensitive	string (enumerated)	Reference: IPC-2547 YES | NO (only applies to character string values)
cautionType	string (enumerated)	Describes the type of warning message. List varies.
changeType	string (enumerated)	ABSOLUTE | DIFFERENTIAL (* check: amount
comparator	string (enumerated)	Reference: IPC-2547 EQ | NE | GT | LT | GE | LE | GTLT | GELE | GTLE | GELT | LTGT | LEGE | LTGE | LEGT
containerPositionType	string	Identifies the type of container location. e.g.. This ContainerPosition can carry Component A.
dateTime	dateTime	Date and Time of the event
decrementMispickCount	positive integer	Most pick & place equipment detects an empty MaterialHandler by counting pickup warnings on one specific MaterialHandler. When sending a MaterialHandlerOutOfItems message this attribute can be used to decrement the count of Pickup Errors charged to the Material Handler by the appropriate number. This will allow the host system to correct the number of warnings for this materialHandler. For example if 3 MisPick warnings were sent to the host which turned out to be an OutOfItem error then a 3 would appear in this attribute.
designator	string	Identifies a unique location on the component, product or container.
diagonalX	double	Projection of diagonal dimension to X-axis
diagonalY	double	Projection of diagonal dimension to Y-axis
diagonalZ	double	Projection of diagonal dimension to Z-axis
endEffectorBaseId	string	Identifier for the base.
endEffectorSegmentId	string	Identifier for the location in End Effector Base
endEffectorToolId	string	Identifier for the End Effector tool.
endEffectorType	string	Type of End Effector
estimatedTimeTillEnd OfComponents	duration	Estimated time till end of components in seconds. Link to data type definition: http://www.w3.org/TR/xmlschema-2/#duration Format: PnYnMnDTnHnMnS
feederDivision	string	Unique location within a feeder or a tray
feederId	string	Identifier of the feeder

feederType	string	A specific type of a feeder
format	string	Type of value (e.g. Binary, ascii, csv, xml).
idCategory	string	Unique category for the ID source (e.g. LOT, BATCH, PRODUCT_SERIAL_NUMBER, MES, {End user specific})
identifier	string	Unique identifier of the instance. Defined inside idCategory.
idType	string (enumerated)	UNIQUE | NONUNIQUE | BULK
initiator	string (enumerated)	A description of how this message was initiated. OPERATOR | AUTOMATIC.
instanceId	string	Instance this parameter is connected to
itemType	string	Identifies the type of instance. e.g. This container can carry Product A or Component B.
laneId	NMTOKEN	Lane identifier
laneList	NMTOKENS	Identifies the lane(s) executing this recipe
materialHandlerTableId	string	Identifier for the specific materialHandler table which contains bank of feeders
materialSupplyArea	string	Unique area of material (i.e. component) supplies found on the equipment
numberOfComponents Left	nonnegative Integer	Number of components left for consumption.
pauseId	string	Pause identifier
position	NMTOKENS	Describe the positional location if the expression is for a multidimensional array of values
processStepId	string	Process step identifier
recipeName	string	Name of specific recipe
recipeStep	string	Identifies the step of the executing recipe
rejectLocation	string	The location where an item is rejected
rotationX	double	Rotation around X-axis
rotationY	double	Rotation around Y-axis
rotationZ	double	Rotation around Z-axis
routeIndex	NMTOKEN	Index of current route step in routeInformation list. See A.5 in implementation Guide.
routeInformation	NMTOKENS	Route of the container through the system
targetDesignator	string	Designator information of target location.
trackId	1..n	Unique location on the equipment. Sometimes referred to as slot.
trayFeederLocation	1..n	Tray feeder location number
trayFeederTower	1..n	Tray feeder tower number
trayId	string	Identifier of the tray
traySection	string	Tray section
vendorId	string	Identification of the vendor of the component lot.
zoneId	NMTOKEN	Area segment identifier
zoneList	NMTOKENS	Identifies the zone(s) executing this recipe

General enumerated attributes:

application	MEASURED	Element is representing measured or read data
	EXPECTED	Element is representing set value(s)
	ALARMLIMITS	Element is representing alarm limits
comparator	EQ | NE | GT | ...	See IPC-2547
initiator	OPERATOR	Operator has initiated the message
	AUTOMATIC	Equipment or other automatic entity has triggered the message

5.9.4.2 Dictionary of Final Assembly and Packaging Recipe Parameters

Under Consideration.

5.9.4.3 Dictionary of Final Assembly and Packaging Process Data Parameters

This table defines examples of different nameIds for Parameter. The table is not comprehensive and *nameIds* specific to application shall be added case by case. But if the topic is listed, the *nameId* should be followed exactly as written.

Each process data parameter can have:

- Measured value(s) (single value or range (min-max))
- Expected value(s) (single value or range (min-max))
- Alarm limits (min-max)

Applicable value sets are application and parameter specific, e.g. in case of dustlevel the maximum limit is the only applicable alarm limit.

nameId	Unit	Assy Task / Process	Description	Equipment Type*
Manipulator				
AxisAcceleration	METER/SECOND^2	Pick & Place	Acceleration of an axis	E1, E3, E4, E5, E6
AxisJerk	METER/SECOND^3	Pick & Place	Jerk of an axis	E1, E3, E4, E5, E6
AxisPosition	METER	Pick & Place	Position of an axis	E1, E3, E4, E5, E6
AxisVelocity	METER/SECOND	Pick & Place	Velocity of an axis	E1, E3, E4, E5, E6
ManipulatorAcc	METER/SECOND^2	Pick & Place	Manipulator acceleration	E1, E3, E4, E5, E6
ManipulatorSpeed	METER/SECOND	Pick & Place	Manipulator movement speed	E1, E3, E4, E5, E6
GlueingUnit				
GlueAmount	KILOGRAM | METER^3	Glueing	The amount of glue applied	E1, E3
GlueTemperature	KELVIN	Glueing	The temperature of glue applied	E1, E3
GlueAge	SECOND	Dispenser	Time for glue in the pump. Set max time; Alarm if time is getting short	E1, E3
InsideTemp	KELVIN	Dispenser	Temperature inside the cell	E1, E3
Weigher				
ObjectWeight	KILOGRAM	Weighting	The weight of object	E1, E2, E3, E5
VacuumUnit				
DustDistance	METER	Depaneling	The milling distance after dust container cleaning	E1, E4
DustLevel	METER	Depaneling	The level of dust in dust container	E1, E4
DustVacuum	PASCAL	Depaneling	The vacuum of dust removal.	E1, E4

Milling unit				
MillingFeedRate	METER/SECOND	Depaneling	The feederate of milling	E1, E4
MillingSpindleSpeed	REVOLUTION/ SECOND	Depaneling	The spindle speed of milling	E1, E4
MillingBitDistance	METER	Depaneling	The total milling distance of current bit	E1, E4
Ionisator				
IonisatorOperation	-	Depaneling	Ionisator status on/off	E1, E4
Gripper				
GrippingForce	NEWTON	Pick & Place	The force used for mechanical gripping	E1, E3, E4
GrippingVacuum	PASCAL	Pick & Place	The vacuum used for gripping	E1, E3, E4
AssemblyForce	NEWTON	Pick & Place	Force applied in assembly direction	E1, E3, E4
ScrewInsertion				
ScrewdrivingTurns	-	Screwdriving	The number of turns screwdrived per screw	E1
ScrewdrivingSpeed	REVOLUTION/ SECOND	Screwdriving	The rpm-speed of screwdriving	E1
ScrewdrivingTime	SECOND	Screwdriving	The time used for screwdriving per screw	E1
ScrewdrivingTorque	NEWTON*METER	Screwdriving	The torque of screwdriving	E1
ScrewHeight	METER	Screwdriving	The final height of screw head when screwdrived to its final position compared to some reference level.	E1
SolderingUnit				
SolderingTemperature	KELVIN	Soldering	Soldering heat	E1
SolderingTinFeedrate	METER/SECOND	Soldering	Tin feeding speed	E1
WeldingUnit				
WeldingEfficiency	PERCENT	Welding	Efficiency of the weld	E1
WeldingEnergy	JOULE	Welding	Consumed energy	E1
WeldingPower	WATT	Welding	Welding power	E1
WeldingPowerLoss	PERCENT	Welding	Power loss during welding	E1
HeatTransferUnit				
HeatTransferDiePad Temperature	KELVIN	Heat Transfer	Die temperature	E1
HeatTransferDwell Time	SECOND	Heat Transfer	Length of time die stays in contact with part being marked	E1
HeatTransferHeadUp Delay	SECOND	Heat Transfer	Length of time stamp allows for label to transfer onto part, with out pulling tape off part.	E1
HeatTransferStamp Pressure	PASCAL	Heat Transfer	Application pressure	E1, E4,
LaserUnit				
LaserBeamMovement Speed	METER/SECOND	Laser marking	The movement speed of laser beam	E1
LaserBulb/diode OperatingTime	SECOND	Laser marking	The bulb/diode operating time	E1
LaserCurrent	AMPERE	Laser marking	The current of laser	E1
LaserPower	WATT	Laser marking	The power of laser	E1
LaserPulseFrequency	HERZ	Laser marking	The pulse frequency of laser	E1

Conveyor				
ConveyorBeltSpeed	METER/SECOND	Transport	Belt speed	E1, E2, E3, E4, E5, E6
ConveyorPalletSpeed	METER/SECOND	Transport	Pallet speed	E1, E2, E3, E4, E5, E6

*EquipmentTypes:
E1 = Assembly cell,
E2 = Conveyor,
E3 = Carton forming cell,
E4 = Router / Depanelling cell,
E5 = Storage / Buffering cell,
E6 = Testhandler

5.9.4.4 Dictionary of Final Assembly and Packaging SubsystemTypes

Subsystem element is defined in IPC-2546 section 4.4.6. Types defined below should be used for subsystemType field. The table is not comprehensive and *subsystemTypes* specific to application shall be added case by case. But if the topic is listed, the *subsystemType* should be followed exactly as written. SubsystemType is used e.g. in 5.9.6.1.1 AlarmId or ErrorId or WarningID: EquipmentSubsystemCaution.

subsystemType	Attribute Type	Examples / Description
AirSupply	string	Air supply of the equipment
Conveyor	string	A transporting mechanism for a item.
EndEffector	string	End effector. e.g. Gripper
EscortMemory	string	A device for storing/transporting information with a pallet
Feeder	string	A material supply e.g. Tray, bowl or tape feeder, magazine
GlueingUnit (*	string	Unit for glue supply/apply
Gripper (*	string	A device for grasping items.
HeatTransferUnit (*	string	A device for heat transfer operation e.g. for decoration
Ionisator	string	Ionisator device used to charge gas molecules to improve dust removal e.g. in depanelling applications
LaserUnit (*	string	Radiator, optics, transport media
Manipulator	string	Manipulator / robot of assembly cell
MillingUnit (*	string	Milling unit of depanelling cell
MotionControl	string	Unit providing motion control capabilities.
PowerSupply	string	Power supply of cell or subunit
Printer	string	Printer device; bubble jet printer, heat transfer printer, laser printer
Reader	string	Barcode or 2D code reader
SafetyDevice	string	Safety door, light curtain, emergency stop
ScrewInsertion (*	string	Screw insertion / screw driving unit
SolderingUnit (*	string	Device for soldering.
VacuumUnit	string	Unit for creating vacuum for vacuum gripping or dust removal
VisionUnit	string	Camera and control system for vision inspection / manipulator teaching/ machine vision etc.
Weigher	string	Weight measurement device
WeldingUnit (*	string	Device for welding

(* Specific types of End Effector

5.9.5 Dictionary of Nested Elements

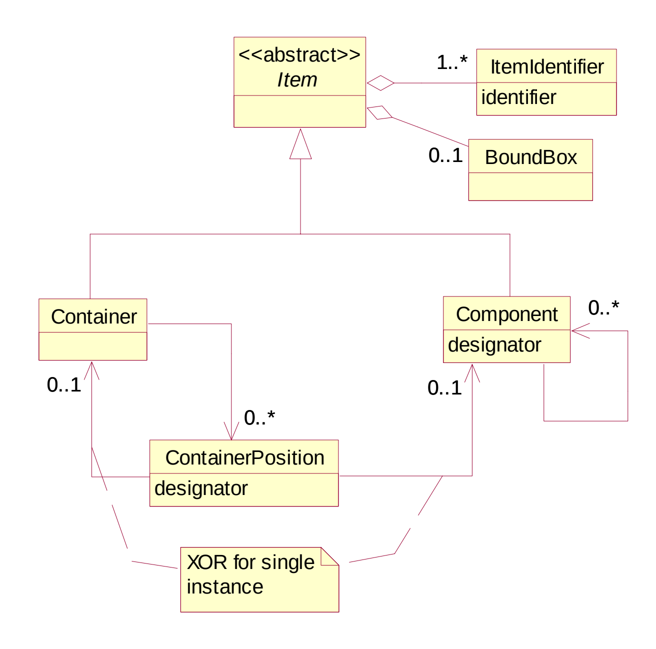


Figure 17 Element relations

Container and Component elements can be generally called Items. Item is an abstract element. It can never be instanced. Direct known subclasses of Item are Container or Component. These are illustrated in details in Figure 17.

A Container has ContainerPosition(s) that can carry either another Container (a box inside of another box) or Component (see Figure 18). ContainerPosition can also be empty (e.g. after initialization).

Component can be carried by Container or it can be attached to the Component (assembly operations). In case of subassembly, relations can be presented as components belonging together.

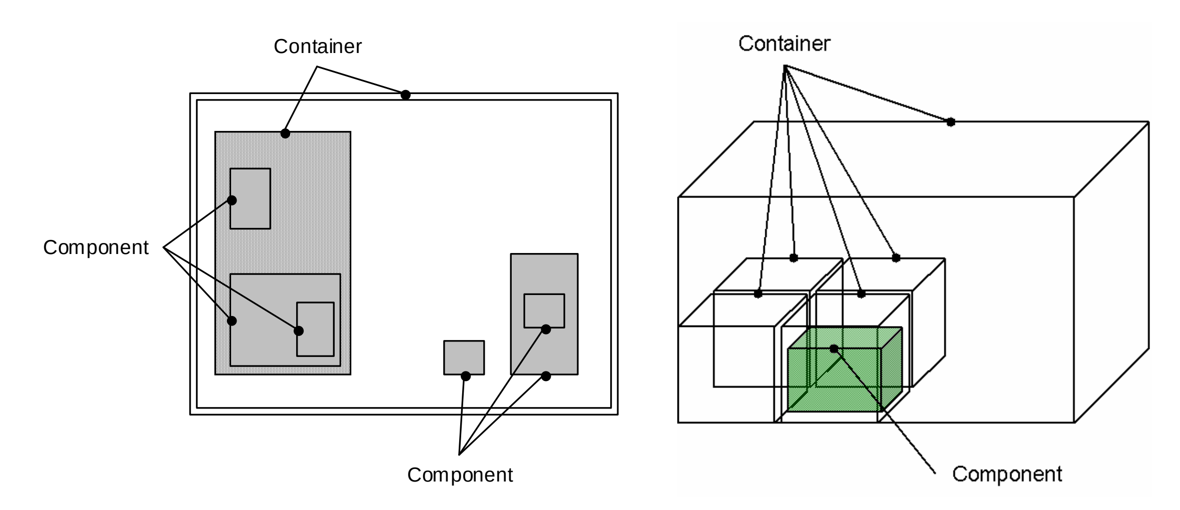


Figure 18 Element relations – example cases from real life

Element: Item <abstract>

Description: Item is an *abstract* element. It can never be instanced. When Item is used the intention is to have one of the defined substitutionElements to appear in place of the Item element. Those substitutionElements must be inherited from Item. See illustration in Figure 19.

Known instances of Item are Container and Component.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
ItemIdentifier	See 5.9.5.2	Identifier of the instance	1-n
itemType	string	Identifies the type of instance. e.g. This container can carry Product A or Component B.	1-1
BoundBox	See 5.9.5.3	Size of item	0-1

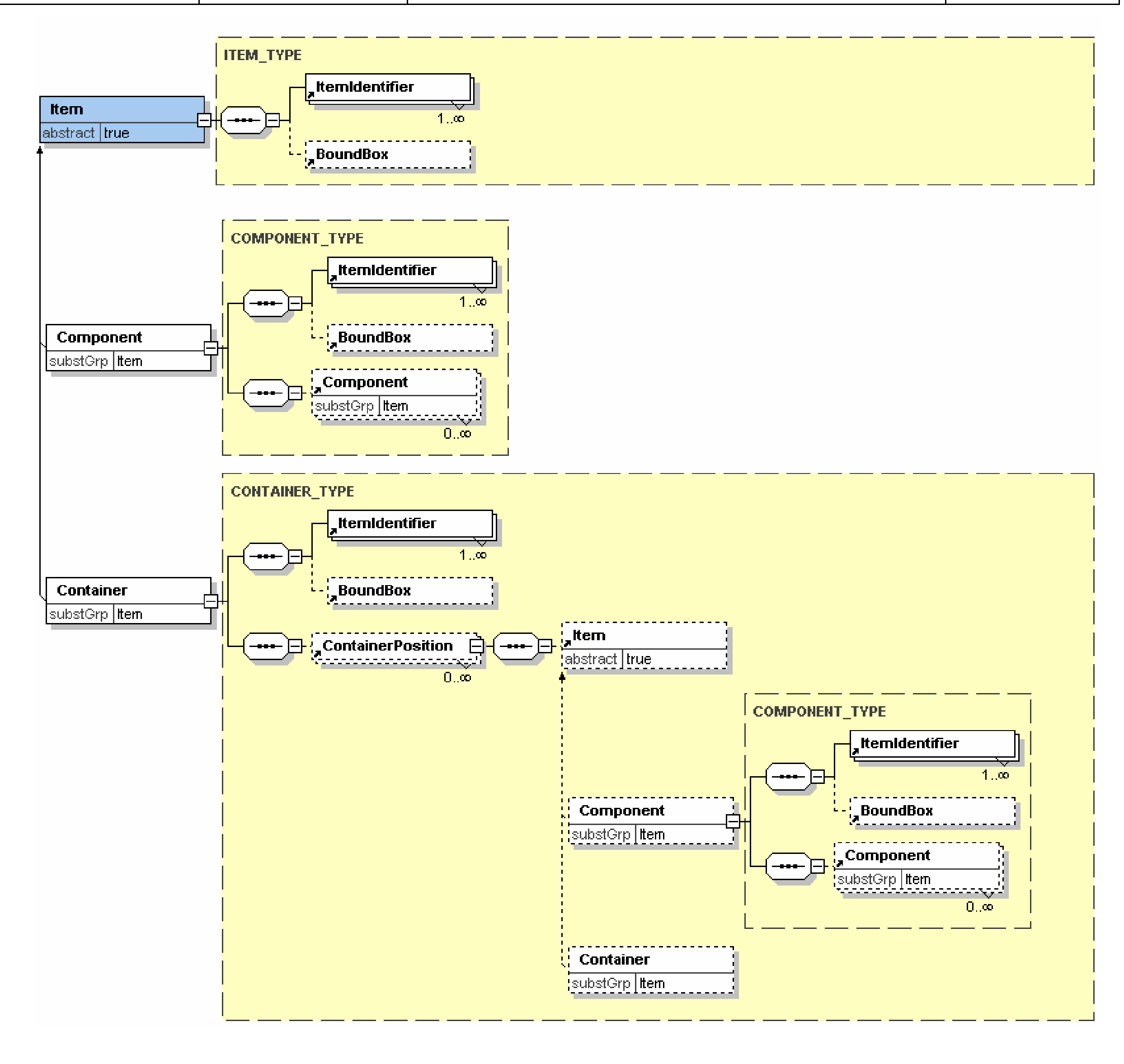


Figure 19 Substitution groups of Item

Element: ItemIdentifier

Description: Identifier for an item instance. (Check implementation guide for additional information: A.2.1 Use of ItemIdentifier)

idType:

UNIQUE | NONUNIQUE | BULK

UNIQUE: An item can be uniquely identified with keypair (idCategory and identifier).

NONUNIQUE: An item has a relevant identification, but it doesn't uniquely identify the item. (e.g.. an identifier that identifies a batch of items.) The keypair (idCategory and identifier) is used for identification.

BULK: Item does not have any identifier.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
idType	string (enumerated)	UNIQUE | NONUNIQUE | BULK	1-1
idCategory	string	Unique category for the ID source (e.g. LOT, BATCH, PRODUCT_SERIAL_NUMBER, MES, {End user specific}) If idType is BULK field shall be 'N/A' (Not Available).	1-1
identifier	string	Unique identifier of the instance within idCategory. If idType is BULK field shall be 'N/A' (Not Available).	1-1

```
<ItemIdentifier
      idType="UNIQUE"
      idCategory="PRODUCT_SERIAL_NUMBER"
      identifier="1234"/>

<ItemIdentifier
      idType="NONUNIQUE"
      idCategory="BATCH"
      identifier="Y2003_W12_1"/>

<ItemIdentifier
      idType="BULK"
      idCategory="N/A"
      identifier="N/A"/>
```

5.9.5.3 Element: BoundBox

Description: Axis aligned bound box defines the size of the item e.g. the minimum box into which the item can be fitted.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
diagonalX	double	Projection of diagonal dimension to X-axis	1-1
diagonalY	double	Projection of diagonal dimension to Y-axis	1-1
diagonalZ	double	Projection of diagonal dimension to Z-axis	1-1
units	string	Units of the parameter	1-1
decade	double	Unit multiplier in powers of 10. Default is 0.	0-1
rotationX	double	Rotation around X-axis	0-1
rotationY	double	Rotation around Y-axis	0-1
rotationZ	double	Rotation around Z-axis	0-1

```
<BoundBox
      diagonalX=”30.0”
      diagonalY=”20.0”
      diagonalZ=”10.0”
      units=”METER”
      decade=”-3”
      rotationX=”0.0”
      rotationY=”0.0”
      rotationZ=”0.0”/>
```

5.9.5.4 Element: Container

Description: Information about a specific container dedicated to transportation of products, components and other containers. Inherited from element: 5.9.5.1 Item.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
ItemIdentifier	See 5.9.5.2	Identifier of the instance	1-n
itemType	string	Identifies the type of instance. e.g. This container can carry Product A.	1-1
BoundBox	See 5.9.5.3	Size of item	0-1
routeInformation	NMTOKENS	Route of the container through the system	0-1
routeIndex	NMTOKEN	Index of current route step in routeInformation list. See A.5 in implementation Guide.	0-1
ContainerPosition	See 5.9.5.5	Information about a specific container position	0-n

```
<Container
      itemType="PalletForProdTT54321"
      routeInformation="L1 R1 L3 R5"
      routeIndex="0">
      <ItemIdentifier
            identifier=”1234”
            idCategory=”MES”
            idType=”UNIQUE”/>
      <ContainerPosition
            designator="1.1"
            containerPositionType="TT54321">
            <Component
                  itemType="TT54321"
                  designator="1.2">
                  <ItemIdentifier
                        identifier=”AZ266533E5Z”
                        idCategory=”MES”
                        idType=”UNIQUE”/>
            </Component>
      </ContainerPosition>
</Container>
```

5.9.5.5 Element: ContainerPosition

Description: Information about a specific container location. Connects it into specific type of container or component.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
designator	string	Unique container location identifier	1-1
containerPositionType	string	Identifies the type of container location. e.g. This ContainerPosition can carry Component A.	1-1
Item	see 5.9.5.1	Information about a specific item. Item is ABSTRACT element and a head of substitution group. Can be substituted with Container or Component.	0-1

```
<ContainerPosition
      designator="1.1"
      containerPositionType="TT54321">
      <Component
            itemType="TT54321"
            designator="1.2">
            <ItemIdentifier
                  identifier=”AZ266533E5Z”
                  idCategory=”MES”
                  idType=”UNIQUE”/>
      </Component>
</ContainerPosition>
```

5.9.5.6 Element: Component

Description: Information about a specific component. Inherited from element: 5.9.5.1 Item.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
ItemIdentifier	see 5.9.5.2	Identifier of the instance. Part identification such as a serial number. Identifies the instance of component.	1-n
itemType	string	Identifies the type of instance. e.g. This component is Component A.	1-1
BoundBox	see 5.9.5.3	Size of item	0-1
designator	string	Identifies a unique location on the component, product or container.	0-1
imageId	string	Reference image of the component.	0-1
recognitionReference	string	Reference name used by the recognition system and/or the recipe.	0-1
Component	see 5.9.5.6	Information about a specific component	0-n

```
<Component
      itemType="part1A"
      designator="S100"
      imageId="2"
      recognitionReference="S100.gf">
      <ItemIdentifier
            identifier="54321-12345"
            idCategory=”MES”
            idType=”UNIQUE”/>
      <Component>
      ...
      </Component>
</Component>
```

5.9.5.7 Element: EndEffector

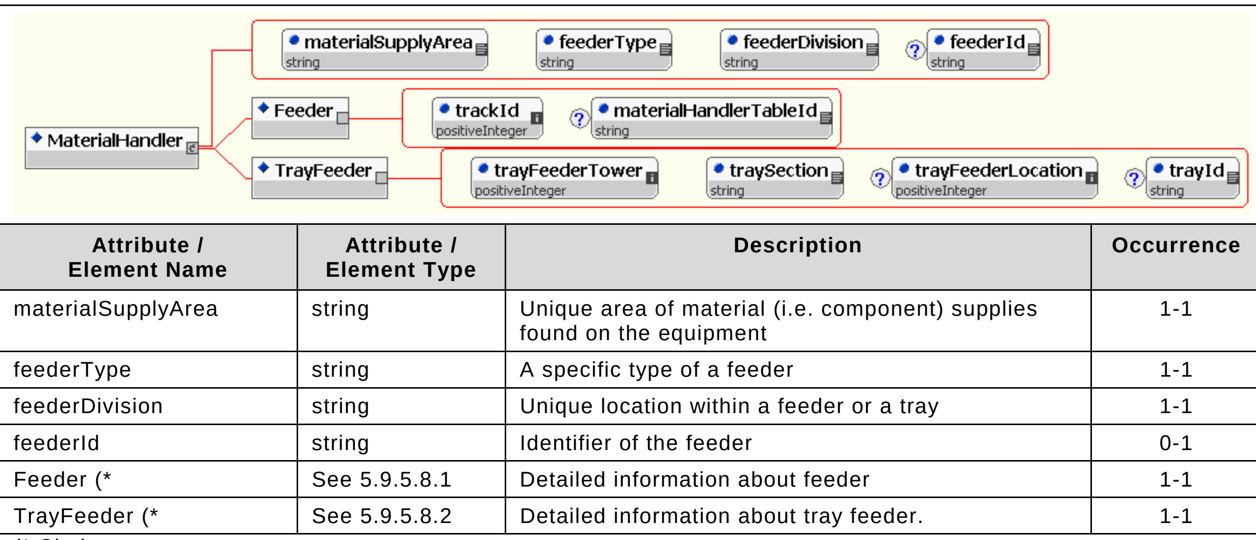
Description: Information about a specific device affecting the component.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
endEffectorType	string	Type of End Effector	1-1
endEffectorBaseId	string	Identifier for the base.	1-1
endEffectorToolId	string	Identifier for the End Effector tool.	0-1
endEffectorSegmentId	string	Identifier for the location in End Effector Base	0-1

```
<EndEffector
       endEffectorType="ServoGripper"
       endEffectorBaseId="2"
       endEffectorToolId="12"
       endEffectorSegmentId="3"/>
```

5.9.5.8 Element: MaterialHandler

Description: Material handler (e.g. tape, bowl or tray feeder, screw shooter) is used to supply items to assembly operation. The attributes associated with a feeder would be used if the component is located on a feeder and the attributes associated with a tray would be used if the component is located on a tray feeder.



Attribute / Element Name	Attribute / Element Type	Description	Occurrence
materialSupplyArea	string	Unique area of material (i.e. component) supplies found on the equipment	1-1
feederType	string	A specific type of a feeder	1-1
feederDivision	string	Unique location within a feeder or a tray	1-1
feederId	string	Identifier of the feeder	0-1
Feeder (*	See 5.9.5.8.1	Detailed information about feeder	1-1
TrayFeeder (*	See 5.9.5.8.2	Detailed information about tray feeder.	1-1

(* Choice

5.9.5.8.1 Sub Element: Feeder

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
trackId	1..n	Unique location on the equipment. Sometimes referred to as slot.	1-1
materialHandlerTableId	string	Identifier for the specific materialHandler table which contains bank of feeders	0-1

5.9.5.8.2 Sub Element: TrayFeeder

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
trayFeederTower	1..n	Tray feeder tower number	1-1
traySection	string	Tray section	1-1
trayFeederLocation	1..n	Tray feeder location number	0-1
trayId	string	Identifier of tray	0-1

```
<MaterialHandler
      materialSupplyArea="2"
      feederType="8mm Tape"
      feederId="65432-1"
      feederDivision="1">
      <Feeder
            trackId="1"
            materialHandlerTableId="1"/>
</MaterialHandler>

<MaterialHandler
      materialSupplyArea="1"
      feederType="TrayMagazine"
      feederId="C453-4321"
      feederDivision="2">
      <TrayFeeder
            trayFeederTower="2"
            traySection="4"
            trayFeederLocation="3"
            trayId="4342"/>
</MaterialHandler>
```

5.9.5.9 Element: ComponentValidation

Description: Information about a specific batch/lot of components. This would be used at the instance of validation of a batch/lot.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
itemType	string	Unique component type identifier that identifies the type of the instance. e.g. This component is Component A.	1-1
vendorId	string	Identification of the vendor of the component lot.	0-1
ItemIdentifier	See 5.9.5.2	Identification(s) such as serial number, lot identifier	0-n

```
<ComponentValidation
      itemType="part1A"
      vendorId="2332-22-2">
      <ItemIdentifier
            idType=”NONUNIQUE”
            idCategory=”BATCH”
            identifier=”4001-300-G0402-Sally-7220”/>
</ComponentValidation>
```

5.9.5.10 Element: Parameter

Description: A record of the name, value and units for an equipment parameter. Optional constraints can also be applied to the parameter. Replaces IPC-2546 section 4.4.4 Parameter in FA&P context.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
nameId	string	The name of the parameter	1-1
instanceId	string	Instance this parameter is connected to	0-1
description	string	Description of the parameter	0-1
DataNumeric	See 5.9.5.11	Data with numeric value	0-n
DataOctet	See 5.9.5.12	Data with octet value	0-n

```
<Parameter
      nameId=”FeedRate”
      instanceId=”X-axis”
      description=”Feedrate for X-axis of robot”>
      <DataNumeric
            application=”MEASURED”
            units=”METER/SECOND”
            decade=”-3”
            value=”56”/>
      <DataNumeric
            application=”EXPECTED”
            units=”METER/SECOND”
            decade=”-3”
            value=”50”
            minimum=”-2000”
            maximum=”2000”
            comparator=”GELE”/>
</Parameter>
```

5.9.5.11 Element: DataNumeric

Description: A record for storing numeric values. Application attribute will define the nature of this numeric information: measured values, expected (set-up) values, or alarm limits (min, max). The same units and decades **shall** be used in all values (value, minimum, maximum). The position attribute is defined using the XML NMTOKENS syntax specified as a single quoted string containing white-space (e.g. SPACE, TAB) separated, alpha-numeric character groups. See also A.6 Parameter value relations and ranges.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
application	string (enumerated)	The type of the element MEASURED | EXPECTED | ALARMLIMITS	1-1
units	string	Units of the parameter	1-1
decade	double	Unit multiplier in powers of 10. Default is 0.	0-1
value	double	Value of the parameter	0-1
minimum	double	Minimum value of the parameter	0-1
maximum	double	Maximum value of the parameter	0-1
comparator	string (enumerated)	Reference: IPC-2547 EQ | NE | GT | LT | GE | LE | GTLT | GELE | GTLE | GELT | LTGT | LEGE | LTGE | LEGT	0-1
position	NMTOKENS	Describe the positional location if the expression is for a multidimensional array of values	0-1

```
<DataNumeric
      application=”EXPECTED”
      units=”METER/SECOND”
      decade=”-3”
      value=”50.0”
      minimum=”-2000.0”
      maximum=”2000.0”
      comparator=”GELE”
      position=”1.3”/>
```

5.9.5.12 Element: DataOctet

Description: A record for storing string, byte or bit sequence value. Application attribute will define the nature of this information: measured values, expected (set-up) values. The position attribute is defined using the XML NMTOKENS syntax specified as a single quoted string containing white-space (e.g. SPACE, TAB) separated, alpha-numeric character groups.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
application	string (enumerated)	The type of the element MEASURED | EXPECTED	1-1
value	string	Value of the parameter	1-1
caseSensitive	string (enumerated)	Reference: IPC-2547 YES | NO (only applies to character string values)	0-1
format	string	Type of value (e.g. binary, ascii, csv, xml).	0-1
position	NMTOKENS	Describe the positional location if the expression is for a multidimensional array of values	0-1

```
<DataOctet
      application=”EXPECTED”
      value=”11001010011100111010”
      format=”binary”/>
```

5.9.5.13 Element: Recipe

Description: The Recipe element uniquely identifies the recipe, program or algorithm set that is being applied at the station. Inherited from IPC-2546 section 4.4.5 Recipe

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
recipeId	string	Recipe identifier	1-1
revision	string	Identifies the revision of the recipe	0-1
laneList	NMTOKENS	Identifies the lane(s) executing this recipe	0-1
zoneList	NMTOKENS	Identifies the zone(s) executing this recipe	0-1
recipeStep	string	Identifies the step of the executing recipe	0-1
command	string	Command in the recipe such as line number or process step.	0-1
description	string	Description of the recipe	0-1

```
<Recipe
      recipeId="VCR-2912"
      revision="4"
      zoneList="1,2"
      laneList="1,2,3"
      recipeStep="step1"
      command="42"
      description="Recipe for inserting cover for product A"/>
```

5.9.6 Extensions to IPC-2541 Mandatory Messages

Extensions to EquipmentAlarm, EquipmentError and EquipmentWarning can be used interchangeably in this section depending on the nature of the event and equipment that triggers this message. In this section each extension is presented under the message it most naturally belongs to. Note that EquipmentInformation extensions are NOT interchangeable.

5.9.6.1 IPC-2541 <EquipmentAlarm or EquipmentError or EquipmentWarning> Messages

AlarmId or ErrorId or WarningId: EquipmentSubsystemCaution

Definition: The equipment detects an alarm, error or warning condition in one of its subsystems. Refer the IPC-2541 for caution levels.

Subsystem: subsystemType is defined in 5.9.4.4.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
MachineError	See 4.4.3	Information about an error in the equipment	1-1

```
<EquipmentAlarm
      dateTime="2000-02-02T11:33:22.00-05:00"
      alarmId="EquipmentSubsystemCaution"
      alarmInstanceId="30465"
      alarmType="PERSONALSAFETY"
      laneList="1,2"
      zoneList="3">
      <Extensions>
            <EquipmentSubsystemCaution>
                  <MachineError
                        vendorErrorCode="St2947-ab12"
                        description="Door was opened while running">
                        <Subsystem
                              subsystemType="SafetyDevice"
                              subsystemId="Front_door"/>
                  </MachineError>
            </EquipmentSubsystemCaution>
      </Extensions>
</EquipmentAlarm>
```

5.9.6.1.2 AlarmId or ErrorId or WarningId: ProcessParameterCaution

Description: Process parameter’s alarm limit has been exceeded. Extended message defines the severity of caution. See also 5.9.4.3 for Process Data Parameters and A.6 Parameter value relations and ranges.

Example: Warning is applicable in case of passing 1st limit defined by user (2000mm). Error or Alarm is applicable in case of passing 2nd or 3rd limit defined by manufacturer (2100mm / HW limit).

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
nameId	string	The name of the parameter	1-1
instanceId	string	Instance this parameter is connected to	0-1
description	string	Description of the caution	0-1
DataNumeric	See 5.9.5.11	Data with numeric value	2-n

ProcessParameterCaution **shall** contain at least two DataNumeric elements. The elements (application = MEASURED and ALARMLIMITS) will explain the reason for the caution message.

```
<EquipmentWarning
      dateTime="2003-10-01T18:45:23.00+03:00"
      warningId = "ProcessParameterCaution"
      warningInstanceId = "12345"
      laneList = "1"
      zoneList = "1">
      <Extensions>
            <ProcessParameterCaution
                  nameId=”AxisPosition”
                  instanceId=”X-axis”
                  description=”X-axis over the high limit”>
                  <DataNumeric
                        application=”MEASURED”
                        units=”METER”
                        decade=”-3”
                        value=”2010”/>
                  <DataNumeric
                        application=”EXPECTED”
                        units=”METER”
                        decade=”-3”
                        value=”1900”/>
                  <DataNumeric
                        application=”ALARMLIMITS”
                        units=”METER”
                        decade=”-3”
                        minimum=”-2000”
                        maximum=”2000”
                        comparator=”GELE”/>
            </ProcessParameterCaution>
      </Extensions>
</EquipmentWarning>
```

5.9.6.2 IPC-2541 <EquipmentAlarm> Messages

Under Consideration

5.9.6.3 IPC-2541 <EquipmentError> Messages

5.9.6.3.1 ErrorId: EquipmentOutOfItem

Definition: The equipment cannot continue processing because there are no components of this type available.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
Item	See 5.9.5.1	Information about a specific item. Item is ABSTRACT element and a head of substitution group. Can be substituted with Container or Component.	1-1
description	string	Human readable description of the caution	0-1

```
<EquipmentError
      dateTime="2003-10-01T18:45:23.00+03:00"
      laneList="1"
      zoneList="1"
      errorId="EquipmentOutOfItem"
      errorInstanceId="12345">
      <Extensions>
```

```
            <EquipmentOutOfItem>
                  <Component
                        itemType="part1A">
                        <ItemIdentifier
                              idType="UNIQUE"
                              idCategory="PRODUCT_SERIAL_NUMBER"
                              identifier="54321-12345"/>
                  </Component>
            </EquipmentOutOfItem>
      </Extensions>
</EquipmentError>
```

5.9.6.4 IPC-2541 <EquipmentWarning> Messages

5.9.6.4.1 WarningId: ItemDidNotTransferSuccessfullyFa

Definition: This is an indication that the item was transferred into or within the equipment and never arrived to its destination.

cautionTypes:

TIMEOUT | JAM

TIMEOUT: The item did not arrive at a location in the expected period of time

JAM: An item was not able to transfer. It is still detected at the starting location.

ItemTypes:

CONTAINER | COMPONENT

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
cautionType	string (enumerated)	Describes the type of warning. TIMEOUT | JAM	1-1
itemType	string (enumerated)	Describes the type of warning item. CONTAINER | COMPONENT	1-1
description	string	Human readable description of the caution	0-1
Item	See 5.9.5.1	Information about specific item. Item is ABSTRACT element and a head of substitution group. Can be substituted with Container or Component.	0-1
Recipe	See 5.9.5.1.3	Identifies the recipe, program or algorithm	0-1

```
<EquipmentWarning
      dateTime="2003-10-01T18:45:23.00+03:00"
      warningId = "ItemDidNotTransferSuccessfullyFa"
      warningInstanceId = "12345"
      laneList = "1"
      zoneList = "1">
      <Extensions>
            <ItemDidNotTransferSuccessfullyFa
                  cautionType="TIMEOUT"
                  itemType="CONTAINER">
                  <Container
                        itemType="PalletForProdTT54321">
                        <ItemIdentifier
                              idType="UNIQUE"
                              idCategory="CONTAINER"
                              identifier="0002"/>
                  </Container>
                  <Recipe
                        recipeId="VCR-2912"
```

```
                        revision="4"/>
            </ItemDidNotTransferSuccessfullyFa>
      </Extensions>
</EquipmentWarning>
```

5.9.6.4.2 WarningId: ItemFailure

Definition: The processed item does not fulfill the specifications. See also 5.9.6.4.5 ItemRecognitionFailureFa.

cautionTypes:

OUTOFSPECIFICATION | OUTOFTOLERANCE

OUTOFSPECIFICATION: Item property does not meet the specifications (e.g. part of the item is missing, item is malformed, marking is fuzzy).

OUTOFTOLERANCE: Item property (e.g. Size, weight, dimension) does not meet the tolerance.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
cautionType	string (enumerated)	Describes the type of information message. OUTOFSPECIFICATION | OUTOFTOLERANCE	1-1
Item	See 5.9.5.1	Information about a specific item. Item is ABSTRACT element and a head of substitution group. Can be substituted with Container or Component.	1-1
description	string	Human readable description of the caution	0-1
EndEffector	See 5.9.5.7	Information about a specific end effector located on an End Effector Base.	0-1
MaterialHandler	See 5.9.5.8	Information about a specific material handler (i.e. materialHandler, tray server).	0-1
Recipe	See 5.9.5.13	Identifies the recipe, program or algorithm.	0-1

```
<EquipmentWarning
      dateTime="2003-10-01T18:45:23.00+03:00"
      warningId = "ItemFailure"
      warningInstanceId = "12345"
      laneList = "1"
      zoneList = "1">
      <Extensions>
            <ItemFailure
                  cautionType=”OUTOFTOLERANCE”
                  description=”Leg1 is bent”>
                  <Component
                        itemType="part1A">
                        <ItemIdentifier
                              identifier="54321-12345"
                              idCategory=”MES”
                              idType=”UNIQUE”/>
                  </Component>
                  <EndEffector
                        endEffectorType="ServoGripper"
                        eEBaseId="2"/>
                  <MaterialHandler
                        materialSupplyArea="2"
                        feederType="8mm Tape"
                        feederId="65432-1"
                        feederDivision="1">
                        <Feeder
```

```
                              trackId="1"/>
                  </MaterialHandler>
            </ItemFailure>
      </Extensions>
</EquipmentWarning>
```

5.9.6.4.3 WarningId: ItemMissPick

Definition: This is an indication that the component was not properly picked up from a feeding device or some other location like container.

cautionTypes:

MISSINGITEM | MISALIGNEDITEM

MISSINGITEM: Component is completely missing from the end effector

MISALIGNEDITEM: Recognition system was not able to correct alignment. This could be because of the following reasons: misaligned (X, Y, Theta)

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
cautionType	string (enumerated)	Describes the type of warning message. MISSINGITEM | MISALIGNEDITEM	1-1
EndEffector	See 5.9.5.7	Information about a specific End Effector located on an End Effector Base.	1-1
MaterialHandler	See 5.9.5.8	Information about a specific material handler (i.e. materialHandler, trayfeeder).	1-1
Item	See 5.9.5.1	Information about a specific item. (i.e. Container or Component. Item is ABSTRACT element and a head of substitution group. Can be substituted with Container or Component.	1-1
description	string	Human readable description of the caution	0-1
Recipe	See 5.9.5.13	Identifies the recipe, program or algorithm	0-1

```
<EquipmentWarning
      dateTime="2003-10-01T18:45:23.00+03:00"
      warningId = "ItemMissPick"
      warningInstanceId = "12345"
      laneList = "1"
      zoneList = "1">
      <Extensions>
            <ItemMissPick
                  cautionType="MISSINGITEM">
                  <EndEffector
                        endEffectorType="ServoGripper"
                        eEBaseId="2"
                        eEToolId="12"
                        eESegmentId="3"/>
                  <MaterialHandler
                        materialSupplyArea="2"
                        feederType="8mm Tape"
                        feederId="65432-1"
                        feederDivision="1">
                        <Feeder
                              trackId="1"/>
                  </MaterialHandler>
                  <Component
                        itemType="part1A">
                        <ItemIdentifier
                              identifier="54321-12345"
```

```
                              idCategory="MES"
                              idType="UNIQUE"/>
                        </Component>
                  </ItemMissPick>
            </Extensions>
</EquipmentWarning>
```

5.9.6.4.4 WarningId: ItemPlacementFailure

Definition: This is an indication that the item was lost between pick and place. This could occur when an item is picked up correctly and the recognition system detects it correctly however the item is not placed on the board.

cautionTypes:

LOSTDURINGMOVEMENT | LOST | MISPLACED

LOSTDURINGMOVEMENT: A component is getting lost from the end effector after component recognition

LOST: Lost.

MISPLACED: A component is misplaced. e.g. a leg of component has bend, because of collision after recognition and component is not placed correctly into the product.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
cautionType	string (enumerated)	Describes the type of information message: LOSTDURINGMOVEMENT | LOST | MISPLACED	1-1
EndEffector	See 5.9.5.7	Information about a specific end effector located on an End Effector Base.	1-1
Item	See 5.9.5.1	Information about a specific item that is not placed into aimed location. Item is ABSTRACT element and a head of substitution group. Can be substituted with Container or Component.	1-1
description	string	Human readable description of the caution	0-1
recipeStep	string	Recipe step when lost occurred	0-1
targetDesignator	string	Designator information of target location.	0-1
MaterialHandler	See 5.9.5.8	Information about a specific material handler (i.e. materialHandler, tray server).	0-1
Recipe	See 5.9.5.13	Identifies the recipe, program or algorithm	0-1
TargetItem	See 5.9.6.4.4.1	Information about product affected. The aimed location.	0-1

5.9.6.4.4.1 TargetItem

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
Item	See 5.9.5.1	Information about the target item where the new item was tried to be placed. Item is ABSTRACT element and a head of substitution group. Can be substituted with Container or Component.	1-1

```
<EquipmentWarning
      dateTime="2003-10-01T18:45:23.00+03:00"
      warningId = "ItemPlacementFailure"
      warningInstanceId = "12345"
      laneList = "1"
      zoneList = "1">
      <Extensions>
            <ItemPlacementFailure
                  cautionType="LOSTDURINGMOVEMENT"
                  targetDesignator="2.3"
                  recipeStep="recipeA-step7">
                  <EndEffector
                        endEffectorType="ServoGripper"
                        eEBaseId="2"/>
                  <Component
                        itemType="part1A">
                        <ItemIdentifier
                              identifier="54321-12345"
                              idCategory=”MES”
                              idType=”UNIQUE”/>
                  </Component>
                  <MaterialHandler
                        materialSupplyArea="2"
                        feederType="8mm Tape"
                        feederId="65432-1"
                        feederDivision="1">
                        <Feeder
                              trackId="1"/>
                  </MaterialHandler>
                  <Recipe
                        recipeId="VCR-2912"
                        revision="4"
                        description="Recipe  for  inserting  cover  for  product
                        A"/>
                  <TargetItem>
                        <Component
                              itemType="TT54321">
                              <ItemIdentifier
                                    identifier="TT54321-1234"
                                    idCategory=”MES”
                                    idType=”UNIQUE”/>
                        </Component>
                  </TargetItem>
            </ItemPlacementFailure>
      </Extensions>
</EquipmentWarning>
```

5.9.6.4.5 WarningId: ItemRecognitionFailureFa

Definition: A recognition failure pertaining to an item. (e.g. barcode, escort memory read/write (I/O operation) failure, shape recognition failure)

cautionTypes:

BADMEASUREMENT | READERROR | IDENTIFIERNOTFOUND | IDENTIFIERMISMATCH

BADMEASUREMENT:	Quality of the fiducial measurement is not good enough
READERROR:	Error happened during reading operation of the identifier tag e.g. escort memory chip / data carrier is misaligned or barcode is dirty.
IDENTIFIERNOTFOUND:	Identifier tag was not found. (e.g. Barcode label is missing).

IDENTIFIERMISMATCH: Item identifier does not match. e.g. Machine vision has recognized the type of a component and it does not match with the expected component type.

ItemTypes:

CONTAINER | COMPONENT

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
cautionType	string (enumerated)	Describes the type of warning. BADMEASUREMENT | READERROR | IDENTIFIERNOTFOUND | IDENTIFIERMISMATCH	1-1
itemType	string (enumerated)	Describes the type of item. CONTAINER | COMPONENT	0-1
description	string	Human readable description of the caution	0-1
Item	See 5.9.5.1	Information of the specific item. Item is ABSTRACT element and a head of substitution group. Can be substituted with Container or Component.	0-1
Fiducial	See 4.4.2	Information about a specific fiducial	0-1
Subsystem	See 4.4.6	Information about a specific Subsystem	0-1
Recipe	See 5.9.5.13	Identifies the recipe, program or algorithm	0-1

```
<EquipmentWarning
      dateTime="2003-10-01T18:45:23.00+03:00"
      warningId = "ItemRecognitionFailureFa"
      warningInstanceId = "12345"
      laneList = "1"
      zoneList = "1">
      <Extensions>
            <ItemRecognitionFailureFa
                  cautionType="BADMEASUREMENT"
                  itemType="CONTAINER">
                  <Container
                        itemType="PalletForProdTT54321">
                        <ItemIdentifier
                              identifier="668VCR255"
                              idCategory=”MES”
                              idType=”UNIQUE”/>
                  </Container>
                  <Fiducial
                        designator="F1"
                        imageId="4"
                        imageShape="Rectangle"
                        recognitionReference="123.gf"/>
                  <Subsystem
                        subsystemType="Medium Resolution Camera"
                        subsystemId="Downward looking: Head1"
                        revision="3.4"/>
                  <Recipe
                        recipeId="VCR-2912"
                        revision="4"
                        zoneList="1,2"
                        laneList="1,2"/>
            </ItemRecognitionFailureFa>
      </Extensions>
</EquipmentWarning>
```

5.9.6.4.6 WarningId: MaterialHandlerLowFa

Definition: The material handler is almost out of components.

cautionTypes:

MEASUREDMATERIALHANDLERLOW | ESTIMATEDMATERIALHANDLERLOW

MEASUREDMATERIALHANDLERLOW: The equipment knows exactly how many components are in the component supply

ESTIMATEDMATERIALHANDLERLOW: The equipment is estimating how many components are in the component supply

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
cautionType	string (enumerated)	Describes the type of warning. MEASUREDMATERIALHANDLERLOW | ESTIMATEDMATERIALHANDLERLOW	1-1
MaterialHandler	See 5.9.5.8	Information about a specific material handler (i.e. materialHandler, tray server).	1-1
estimatedTimeTill EndOfComponents	duration	Estimated time till end of components in seconds. Link to data type definition: http://www.w3.org/TR/xmlschema-2/#duration Format: PnYnMnDTnHnMnS	0-1
description	string	Human readable description of the caution	0-1
numberOfComponents Left	nonNegative Integer	Number of components left for consumption.	0-1
Item	See 5.9.5.1	Information about a specific component. Item is ABSTRACT element and a head of substitution group. Can be substituted with Container or Component.	0-1

```
<EquipmentWarning
      dateTime="2003-10-01T18:45:23.00+03:00"
      warningId = "MaterialHandlerLowFa"
      warningInstanceId = "12345"
      laneList = "1"
      zoneList = "1">
      <Extensions>
            <MaterialHandlerLowFa
                  cautionType="MEASUREDMATERIALHANDLERLOW"
                  estimatedTimeTillEndOfComponents="PT1H30M00S"
                  numberOfComponentsLeft="55">
                  <MaterialHandler
                        materialSupplyArea="2"
                        feederType="8mm Tape"
                        feederId="65432-1"
                        feederDivision="1">
                        <Feeder
                              trackId="1"/>
                  </MaterialHandler>
            </MaterialHandlerLowFa>
      </Extensions>
</EquipmentWarning>
```

5.9.6.4.7 WarningId: MaterialHandlerOutOfItemsFa

Definition: The material handler is determined to be out of components.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
MaterialHandler	See 5.9.5.8	Information about a specific material handler (i.e. materialHandler, tray server).	1-1
Item	See 5.9.5.1	Information about a specific item. Item is ABSTRACT element and a head of substitution group. Can be substituted with Container or Component.	1-1
decrementMispickCount	positive integer	Most pick & place equipment detects an empty MaterialHandler by counting pickup warnings on one specific MaterialHandler. When sending a MaterialHandlerOutOfItems message this attribute can be used to decrement the count of Pickup Errors charged to the Material Handler by the appropriate number. This will allow the host system to correct the number of warnings for this materialHandler. For example if 3 MisPick warnings were sent to the host which turned out to be an OutOfItem error then a 3 would appear in this attribute.	0-1
description	string	Human readable description of the caution	0-1

```
<EquipmentWarning
      dateTime="2003-10-01T18:45:23.00+03:00"
      warningId = "MaterialHandlerOutOfItemsFa"
      warningInstanceId = "12345"
      laneList = "1"
      zoneList = "1">
      <Extensions>
            <MaterialHandlerOutOfItemsFa
                  decrementMisPickCount="3">
                  <MaterialHandler
                        materialSupplyArea="2"
                        feederType="8mm Tape"
                        feederId="65432-1"
                        feederDivision="1">
                        <Feeder
                              trackId="1"/>
                  </MaterialHandler>
                  <Component
                        itemType="part1A">
                        <ItemIdentifier
                              identifier="54321-12345"
                              idCategory="MES"
                              idType="UNIQUE"/>
                  </Component>
            </MaterialHandlerOutOfItemsFa>
      </Extensions>
</EquipmentWarning>
```

5.9.6.4.8 WarningId: MaterialHandlerProblemFa

Definition: This event occurs when the equipment has tried to pick a component out of a materialHandler, but is not able to get one, and it has been determined that the materialHandler is not out of components. One possible reason might be jam of the tape.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
MaterialHandler	See 5.9.5.8	Information about a specific material handler (i.e. materialHandler, tray server).	1-1
description	string	Human readable description of the caution	0-1
Item	See 5.9.5.1	Information about a specific item. Item is ABSTRACT element and a head of substitution group. Can be substituted with Container or Component.	0-1

```
<EquipmentWarning
      dateTime="2003-10-01T18:45:23.00+03:00"
      warningId = "MaterialHandlerProblemFa"
      warningInstanceId = "12345"
      laneList = "1"
      zoneList = "1">
      <Extensions>
            <MaterialHandlerProblemFa>
                  <MaterialHandler
                        materialSupplyArea="2"
                        feederType="8mm Tape"
                        feederId="65432-1"
                        feederDivision="1">
                        <Feeder
                              trackId="1"/>
                  </MaterialHandler>
            </MaterialHandlerProblemFa>
      </Extensions>
</EquipmentWarning>
```

5.9.6.5 IPC-2541 <EquipmentInformation> Messages

5.9.6.5.1 InformationId: ItemReject

Definition: The equipment is rejecting an item. The reason for rejection is determined by other event like ItemMissPick, ItemRecognitionFailureFa or ItemFailure.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
rejectLocation	string	The location where an item is rejected	1-1
description	string	Human readable description of the information	0-1
Item	See 5.9.5.1	Information about a specific item. Item is ABSTRACT element and a head of substitution group. Can be substituted with Container or Component.	0-1

```
<EquipmentInformation
      dateTime="2003-10-01T18:45:23.00+03:00"
      informationId="ItemReject"
      laneList = "1"
      zoneList = "1-5">
      <Extensions>
            <ItemReject
                  rejectLocation="Front-Left">
```

```
                        <Component
                              itemType="part1A">
                              <ItemIdentifier
                                    identifier="54321-12345"
                                    idCategory=”MES”
                                    idType=”UNIQUE”/>
                        </Component>
                  </ItemReject>
            </Extensions>
</EquipmentInformation>
```

5.9.6.5.2 InformationId: MaterialHandlerAmountChangeFa

Definition: The material handler has been refilled with components or components have been taken out of the material handler.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
MaterialHandler	See 5.9.5.8	Information about a specific material handler (i.e. material handler, tray server).	1-1
description	string	Human readable description of the information	0-1
initiator	string (enumerated)	A description of how this message was initiated. OPERATOR | AUTOMATIC.	0-1
Amount	See 5.9.6.5.2.1	Amount of changed component	0-1
ComponentValidation	See 5.9.5.9	Information about a specific batch/lot of components	0-1
Item	See 5.9.5.1	Information about a specific item. Item is ABSTRACT element and a head of substitution group. Can be substituted with Container or Component.	0-1

5.9.6.5.2.1 Sub Element: Amount

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
amount	integer	Amount of components filled into (>0) or taken away from (<0) the material handler.	1-1
changeType	string (enumerated)	ABSOLUTE | DIFFERENTIAL	1-1

```
<EquipmentInformation
      dateTime="2003-10-01T18:45:23.00+03:00"
      informationId="MaterialHandlerAmountChangeFa"
      laneList = "1"
      zoneList = "1-5">
      <Extensions>
            <MaterialHandlerAmountChangeFa
                  initiator="OPERATOR">
                  <MaterialHandler
                        materialSupplyArea="2"
                        feederType="8mm Tape"
                        feederId="65432-1"
                        feederDivision="1">
                        <Feeder
                              trackId="1"/>
                  </MaterialHandler>
                  <Amount
                        amount="200"
                        changeType="ABSOLUTE"/>
```

```
                  <ComponentValidation
                        itemType="part1A">
                        <ItemIdentifier
                              identifier="54321-12345"
                              idCategory="BATCH"
                              idType="NONUNIQUE"/>
                  </ComponentValidation>
            </MaterialHandlerAmountChangeFa>
      </Extensions>
</EquipmentInformation>
```

5.9.6.5.3 InformationId: MaterialHandlerInstallFa

Definition: The material handler is placed on the equipment.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
MaterialHandler	See 5.9.5.8	Information about a specific material handler (i.e. materialHandler, tray server).	1-1
description	string	Human readable description of the information	0-1
initiator	string (enumerated)	A description of how this message was initiated. OPERATOR | AUTOMATIC.	0-1
Item	See 5.9.5.1	Information about a specific item. Item is ABSTRACT element and a head of substitution group. Can be substituted with Container or Component.	0-1
ComponentValidation	See 5.9.5.9	Information about a specific batch/lot of components	0-1

```
<EquipmentInformation
      dateTime="2003-10-01T18:45:23.00+03:00"
      informationId="MaterialHandlerInstallFa"
      laneList = "1"
      zoneList = "1-5">
      <Extensions>
            <MaterialHandlerInstallFa
                  initiator="OPERATOR">
                  <MaterialHandler
                        materialSupplyArea="2"
                        feederType="8mm Tape"
                        feederId="65432-1"
                        feederDivision="1">
                        <Feeder
                              trackId="1"/>
                  </MaterialHandler>
                  <ComponentValidation
                        itemType="SOIC-16"/>
            </MaterialHandlerInstallFa>
      </Extensions>
</EquipmentInformation>
```

5.9.6.5.4 InformationId: MaterialHandlerUnInstallFa

Definition: The material handler has been removed from the equipment.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
MaterialHandler	See 5.9.5.8	Information about a specific material handler (i.e. materialHandler, tray server).	1-1
description	string	Human readable description of the information	0-1
initiator	string (enumerated)	A description of how this message was initiated. OPERATOR | AUTOMATIC.	0-1
Item	See 5.9.5.1	Information about a specific item. Item is ABSTRACT element and a head of substitution group. Can be substituted with Container or Component. Item is ABSTRACT element and a head of substitution group. Can be substituted with Container or Component.	0-1

```
<EquipmentInformation
      dateTime="2003-10-01T18:45:23.00+03:00"
      informationId="MaterialHandlerUnInstallFa"
      laneList = "1"
      zoneList = "1-5">
      <Extensions>
            <MaterialHandlerUnInstallFa
                  initiator="OPERATOR">
                  <MaterialHandler
                        materialSupplyArea="2"
                        feederType="8mm Tape"
                        feederId="65432-1"
                        feederDivision="1">
                        <Feeder
                              trackId="1"/>
                  </MaterialHandler>
            </MaterialHandlerUnInstallFa>
      </Extensions>
</EquipmentInformation>
```

5.9.6.5.5 InformationId: ProcessDataReportFa

Definition: A report containing process data in order to permit SPC (Statistical Process Control) analysis. Replaces extension 4.5.1.6 ProcessDataReport.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
nameId	string	The name of the report	1-1
Parameter	See 5.9.5.10	Parameter information.	1-n
description	string	Description of the report	0-1
Item	See 5.9.5.1	Information about a specific item(s). Item is ABSTRACT element and a head of substitution group. Can be substituted with Container or Component.	0-n

```
<EquipmentInformation
      dateTime="2003-10-01T18:45:23.00+03:00"
      informationId="ProcessDataReportFa"
      laneList = "1"
      zoneList = "1-5">
      <Extensions>
            <ProcessDataReportFa
                  nameId=”Router:ManipulatorReport”
                  description=””
                  <Parameter
                        nameId=”FeedRate”
                        instanceId=”X-axis”
                        description=”Feedrate of X-axis”>
                        <DataNumeric
                              application=”MEASURED”
                              units=”METER/SECOND”
                              decade=”-3”
                              value=”56”/>
                        <DataNumeric
                              application=”EXPECTED”
                              units=”METER/SECOND”
                              value=”50”
                              minimum=”-2000”
                              maximum=”2000”
                              decade=”-3”
                              comparator=”GELE”/>
                  </Parameter>
            </ProcessDataReportFa>
      </Extensions>
</EquipmentInformation>
```

5.9.6.6 IPC-2541 <EquipmentParameterModified> Message

5.9.6.6.1 ParameterChangeFa

Definition: This is an extension to the IPC-2541 message. This extension reports modification of a parameter.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
ToParameter	See 5.9.5.10 Parameter	Information about current parameter value.	1-1
FromParameter	See 5.9.5.10 Parameter	Information about previous parameter value	0-1
description	string	Human readable description of the event	0-1
initiator	string (enumerated)	A description of how this message was initiated. OPERATOR | AUTOMATIC.	0-1

```
<EquipmentParameterModified
      dateTime="2003-10-01T18:45:23.00+03:00"
      parameter="FeedRate">
      <Extensions>
            <ParameterChangeFa
                  initiator="OPERATOR">
                  <ToParameter
                        nameId=”FeedRate”
                        instanceId=”X-axis”
                        description=”Feedrate of X-axis”>
                        <DataNumeric
                              application=”EXPECTED”
```

```
                              units=”METER/SECOND”
                              value=”50”
                              minimum=”-2000”
                              maximum=”2000”
                              decade=”-3”
                              comparator=”GELE”/>
                  </ToParameter>
                  <FromParameter
                        nameId=”FeedRate”
                        instanceId=”X-axis”
                        description=”Feedrate of X-axis”>
                        <DataNumeric
                              application=”EXPECTED”
                              units=”METER/SECOND”
                              value=”100”
                              minimum=”-1000”
                              maximum=”1000”
                              decade=”-3”
                              comparator=”GELE”/>
                  </FromParameter>
            </ParameterChangeFa>
      </Extensions>
</EquipmentParameterModified>
```

5.9.6.7 IPC-2541 <ItemWorkStart> Messages

5.9.6.7.1 TargetItem

Definition: A collection of information associated with the start of the work for this product by the equipment.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
Item	See 5.9.5.1	Information about a specific item. Item is ABSTRACT element and a head of substitution group. Can be substituted with Container or Component.	1-1

```
<ItemWorkStart
      dateTime="2003-10-01T18:45:23.00+03:00"
      itemInstanceId="001"
      laneId="1"
      zoneId="2">
      <Extensions>
            <TargetItem>
                  <Component
                        itemType="part1A">
                        <ItemIdentifier
                              identifier="54321-12345"
                              idCategory=”MES”
                              idType=”UNIQUE”/>
                  </Component>
            </TargetItem>
      </Extensions>
</ItemWorkStart>
```

5.9.6.8 IPC-2541 <ItemWorkPause> Messages

5.9.6.8.1 TargetItem

Definition: A collection of information associated with the pause of the work for this product by the equipment.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
Item	See 5.9.5.1	Information about a specific item. Item is ABSTRACT element and a head of substitution group. Can be substituted with Container or Component.	1-1

```
<ItemWorkPause
      dateTime="2003-10-01T18:45:23.00+03:00"
      itemInstanceId="001"
      laneId="1"
      zoneId="2"
      pauseId="Paused waiting for parts">
      <Extensions>
            <TargetItem>
                  <Component
                        itemType="part1A">
                        <ItemIdentifier
                              identifier="54321-12345"
                              idCategory=”MES”
                              idType=”UNIQUE”/>
                  </Component>
            </TargetItem>
      </Extensions>
</ItemWorkPause>
```

5.9.6.9 IPC-2541 <ItemWorkResume> Messages

5.9.6.9.1 TargetItem

Definition: A collection of information associated with the resume of the work for this product by the equipment.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
Item	See 5.9.5.1	Information about a specific item. Item is ABSTRACT element and a head of substitution group. Can be substituted with Container or Component.	1-1

```
<ItemWorkResume
      dateTime="2003-10-01T18:45:23.00+03:00"
      itemInstanceId="001"
      laneId="1"
      zoneId="2"
      <Extensions>
            <TargetItem>
                  <Component
                        itemType="part1A">
                        <ItemIdentifier
                              identifier="54321-12345"
                              idCategory=”MES”
                              idType=”UNIQUE”/>
                  </Component>
            </TargetItem>
      </Extensions>
</ItemWorkResume>
```

5.9.6.10 IPC-2541 <ItemWorkAbort> Messages

5.9.6.10.1 TargetItem

Definition: A collection of information associated with the abort of the work for this product by the equipment.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
Item	See 5.9.5.1	Information about a specific item. Item is ABSTRACT element and a head of substitution group. Can be substituted with Container or Component.	1-1

```
<ItemWorkAbort
      dateTime="2003-10-01T18:45:23.00+03:00"
      itemInstanceId="001"
      laneId="1"
      zoneId="2"
      abortId="Aborted due to bad material">
      <Extensions>
            <TargetItem>
                  <Component
                        itemType="part1A">
                        <ItemIdentifier
                              identifier="54321-12345"
                              idCategory=”MES”
                              idType=”UNIQUE”/>
                  </Component>
            </TargetItem>
      </Extensions>
</ItemWorkAbort>
```

5.9.6.11 IPC-2541 <ItemWorkComplete> Messages

5.9.6.11.1 TargetItemComp

Description: A collection of information associated with the completion of the work for this product by the equipment.

ItemStatus:

NOTPROCESSED If the item arrived at the equipment but was passed through and not processed.

PROCESSED All tasks are successfully completed but test result (OK | FAILED) is not available.

OK All tasks are successfully completed AND test result is passed.

FAILED Test result is failed OR one or more tasks were not successfully completed.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
Item	See 5.9.5.1	Information about a specific item. Item is ABSTRACT element and a head of substitution group. Can be substituted with Container or Component.	1-1
itemStatus	string (enumerated)	NOTPROCESSED | PROCESSED | OK | FAILED	0-1

```
<ItemWorkComplete
      dateTime="2003-10-01T18:45:23.00+03:00"
      itemInstanceId="001"
      laneId="1"
      zoneId="2">
      <Extensions>
            <TargetItemComp
                  itemStatus="OK">
                  <Component
                        itemType="part1A">
                        <ItemIdentifier
                              identifier="54321-12345"
                              idCategory=”MES”
                              idType=”UNIQUE”/>
                  </Component>
            </TargetItemComp>
      </Extensions>
</ItemWorkComplete>
```

5.9.6.12 IPC-2541 <ItemIdentifierRead> Messages

5.9.6.12.1 TargetItem

Definition: Type of the Item that is identified

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
Item	See 5.9.5.1	Information about a specific item. Item is ABSTRACT element and a head of substitution group. Can be substituted with Container or Component.	1-1

```
<ItemIdentifierRead
      dateTime="2003-10-01T18:45:23.00+03:00"
      itemInstanceId="001"
      laneId="2"
      zoneId="2"
      scannerId="Input Conveyor, Placer 1-IC">
      <Extensions>
            <TargetItem>
                  <Component
                        itemType="part1A">
                        <ItemIdentifier
                              identifier="54321-12345"
                              idCategory=”MES”
                              idType=”UNIQUE”/>
                  </Component>
            </TargetItem>
      </Extensions>
</ItemIdentifierRead>
```

5.9.6.13 IPC-2541 <EquipmentSelectedRecipeModified> Messages

5.9.5.13.1 EquipmentRecipeChangeFa

Definition: Additional information of specific recipe modification

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
description	string	Description of the change	0-1
revision	string	Revision number of recipe	0-1
initiator	string (enumerated)	A description of how this message was initiated. OPERATOR | AUTOMATIC.	0-1

```
<EquipmentSelectedRecipeModified
      dateTime="2003-10-01T18:45:23.00+03:00"
      recipeId="12345 Rev C"
      laneList="1-3,5"
      zoneList="1"
      action="MODIFY">
      <Extensions>
            <EquipmentRecipeChangeFa
                  revision="1.0.2"
                  initiator="OPERATOR"/>
      </Extensions>
</EquipmentSelectedRecipeModified>
```

5.9.6.14 IPC-2541 <EquipmentNonSelectedRecipeModified> Messages

5.9.6.14.1 EquipmentRecipeChangeFa

Definition: Additional information of specific recipe modification

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
description	string	Description of the change	0-1
revision	string	Revision number of recipe	0-1
initiator	string (enumerated)	A description of how this message was initiated. OPERATOR | AUTOMATIC.	0-1

```
<EquipmentNonSelectedRecipeModified
      dateTime="2003-10-01T18:45:23.00+03:00"
      recipeId="Product A Top Side Line 1"
      action="CREATE">
      <Extensions>
            <EquipmentRecipeChangeFa
                  revision="1.0.2"
                  initiator="OPERATOR"/>
      </Extensions>
</EquipmentNonSelectedRecipeModified>
```

5.9.7 New Events

5.9.7.1 Event: ItemInitialize

State Change: No state change

Description: Event for providing information about initialisation of assembly structure of a product. With this message can be presented the absolute structure of component hierarchy.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
dateTime	dateTime	Date and Time of the event	1-1
laneId	NMTOKEN	Lane identifier	1-1
zoneId	NMTOKEN	Area segment identifier	1-1
RootItem	See 5.9.7.1.1	Root item under focus. All directly affected children are presented.	1-1
description	string	Human readable description of the event	0-1
initiator	string (enumerated)	A description of how this message was initiated. OPERATOR | AUTOMATIC.	0-1
ParentItem	See 5.9.7.1.1	Parent item that is affected	0-1

5.9.7.1.1 RootItem, ParentItem

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
Item	See 5.9.5.1	Information about the specific item. Item is ABSTRACT element and a head of substitution group. Can be substituted with Container or Component.	1-1

```
<ItemInitialize
      dateTime="2003-03-19T19:50:10.00+03:00"
      laneId="1"
      zoneId="1"
      initiator="OPERATOR">
      <RootItem>
            <Component
                  itemType="PalletForProdTT54321">
                  <ItemIdentifier
                        idType=”UNIQUE”
                        idCategory=”CONTAINER”
                        identifier="0002"/>
            </Component>
      </RootItem>
      <ParentItem>
            <Component
                  itemType="FrameForProdTT54321">
                  <ItemIdentifier
                        idType=”UNIQUE”
                        idCategory=”FRAME”
                        identifier="0001"/>
            </Component>
      </ParentItem>
</ItemInitialize>
```

5.9.7.2 Event: ItemChange

State Change: No state change

Description: Event for providing information about change of assembly structure of a product. This happens when something is inserted into or removed from assembly. Same situation happens also in case of merging or divergence material flows affecting several containers. Hierarchical presentation of *ChildItem* can be given.

actionType:

CREATE | ATTACH | DETACH

CREATE Creation of new item tree structure

ATTACH Attach an item or an item tree into an existing item.

DETACH Removes an item or an item tree structure from an existing item.

Check implementation guide: A.4 Usage of ItemChange.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
dateTime	dateTime	Date and Time of the event	1-1
actionType	string (enumerated)	Type of modify action: CREATE | ATTACH | DETACH	1-1
laneId	NMTOKEN	Lane identifier	1-1
zoneId	NMTOKEN	Area segment identifier	1-1
RootItem	See 5.9.7.1.1	Root item that identifies the product or container. Key used in management system	1-1
ParentItem	See 5.9.7.1.1	Parent item that is affected (*	1-1(*
ChildItem	See 5.9.7.2.1	Item under focus. All affected children are presented.	1-1
description	string	Human readable description of the event	0-1

(* If ParentItem is a Container the affected ContainerPosition **shall** be presented.

5.9.7.2.1 RootItem, ParentItem, ChildItem

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
Item	See 5.9.5.1	Information about the specific item. Item is ABSTRACT element and a head of substitution group. Can be substituted with Container or Component.	1-1

```
<ItemChange
      dateTime="2002-09-24T11:44:00.00+03:00"
      actionType="ATTACH"
      laneId="1"
      zoneId="2">
      <RootItem>
            <Container
                  itemType="ContainerA">
                  <ItemIdentifier
                        identifier="ContA-1234"
                        idCategory=”MES”
                        idType=”UNIQUE”/>
            </Container>
      </RootItem>
      <ParentItem>
            <Container
                  itemType="ContainerA">
```

```
                  <ItemIdentifier
                        identifier="ContA-1234"
                        idCategory="MES"
                        idType="UNIQUE"/>
                  <ContainerPosition
                        designator="1.1"
                        containerPositionType="TT54321"/>
            </Container>
      </ParentItem>
      <ChildItem>
            <Component
                  itemType="TT54321">
                  <ItemIdentifier
                        identifier="TT54321-1234"
                        idCategory="MES"
                        idType="UNIQUE"/>
                  <Component
                        itemType="TT54322"
                        designator="1.1"/>
                        <ItemIdentifier
                              identifier="AZ266533E5Z1"
                              idCategory="MES"
                              idType="UNIQUE"/>
                  </Component>
                  <Component
                        itemType="TT54323"
                        designator="1.2"/>
                        <ItemIdentifier
                              identifier="AZ266533E5Z2"
                              idCategory="MES"
                              idType="UNIQUE"/>
                  </Component>
            </Component>
      </ChildItem>
</ItemChange>
```

5.9.7.3 Event: ProcessStepStart

StateChange: No state change

Description: This event occurs when process is started in a piece of equipment. Process is related into the manufacturing of the Item either directly or indirectly. The ProcessStepComplete, ProcessStepAbort or ProcessStepPause events may follow this event.

Example of process steps for one item:

1. Dispensing of gasket
2. Insertion of a cover.
3. Screwing screws in the corners of the cover.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
dateTime	dateTime	Date and Time of the event	1-1
processStepId	string	Process step identifier	1-1
laneList	NMTOKENS	Identifies the lane(s)	1-1
zoneList	NMTOKENS	Identifies the zone(s)	1-1
description	string	Human readable description of the event	0-1
Item	See 5.9.5.1	Identifier of the instance. Item is ABSTRACT element and a head of substitution group. Can be substituted with Container or Component.	0-n
Subsystem	See 4.4.6	Information about a specific subsystem that the process is related	0-1

```
<ProcessStepStart
      dateTime="2003-03-19T19:50:10.00+03:00"
      processStepId="process2"
      laneList="1"
      zoneList="1, 2, 3"/>
      <Container
            itemType="PalletForProdTT54321"
            <ItemIdentifier
                  idType=”UNIQUE”
                  idCategory=”CONTAINER”
                  identifier="0002"/>
      </Container>
      <Subsystem
            subsystemType="LaserUnit"
            subsystemId="Laser_writer"/>
</ProcessStepStart>
```

5.9.7.4 Event: ProcessStepPause

StateChange: No state change

Description: This event occurs when a process is paused. Either a ProcessStepResume event or a ProcessStepAbort event must follow.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
dateTime	dateTime	Date and Time of the event	1-1
processStepId	string	Process step identifier	1-1
laneList	NMTOKENS	Identifies the lane(s)	1-1
zoneList	NMTOKENS	Identifies the zone(s)	1-1
pauseId	string	Pause identifier	1-1
description	string	Human readable description of the event	0-1
Item	See 5.9.5.1	Identifier of the instance. Item is ABSTRACT element and a head of substitution group. Can be substituted with Container or Component.	0-n
Subsystem	See 4.4.6	Information about a specific subsystem that the process is related	0-1

```
<ProcessStepPause
      dateTime="2003-03-19T19:50:10.00+03:00"
      processStepId="process2"
      laneList="1"
```

```
        zoneList="1, 2, 3"
        pauseId=”pause23” />
        <Container
              itemType="PalletForProdTT54321"
              <ItemIdentifier
                    idType=”UNIQUE”
                    idCategory=”CONTAINER”
                    identifier="0002"/>
        </Container>
        <Subsystem
              subsystemType="LaserUnit"
              subsystemId="Laser_writer"/>
</ProcessStepPause>
```

5.9.7.5 Event: ProcessStepResume

StateChange: No state change

Description: This event occurs when a process is resumed.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
dateTime	dateTime	Date and Time of the event	1-1
processStepId	string	Process step identifier	1-1
laneList	NMTOKENS	Identifies the lane(s)	1-1
zoneList	NMTOKENS	Identifies the zone(s)	1-1
description	string	Human readable description of the event	0-1
Item	See 5.9.5.1	Identifier of the instance. Item is ABSTRACT element and a head of substitution group. Can be substituted with Container or Component.	0-n
Subsystem	See 4.4.6	Information about a specific subsystem that the process is related	0-1

```
<ProcessStepResume
        dateTime="2003-03-19T19:50:10.00+03:00"
        processStepId="process2"
        laneList="1"
        zoneList="1, 2, 3"/>
        <Container
              itemType="PalletForProdTT54321"
              <ItemIdentifier
                    idType=”UNIQUE”
                    idCategory=”CONTAINER”
                    identifier="0002"/>
        </Container>
        <Subsystem
              subsystemType="LaserUnit"
              subsystemId="Laser_writer"/>
</ProcessStepResume>
```

5.9.7.6 Event: ProcessStepAbort

StateChange: No state change

Description: This event occurs when a process is aborted.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
dateTime	dateTime	Date and Time of the event	1-1
processStepId	string	Process step identifier	1-1
laneList	NMTOKENS	Identifies the lane(s)	1-1
zoneList	NMTOKENS	Identifies the zone(s)	1-1
abortId	string	Abort identifier	1-1
description	string	Human readable description of the event	0-1
Item	See 5.9.5.1	Identifier of the instance. Item is ABSTRACT element and a head of substitution group. Can be substituted with Container or Component.	0-n
Subsystem	See 4.4.6	Information about a specific subsystem that the process is related	0-1

```
<ProcessStepAbort
      dateTime="2003-03-19T19:50:10.00+03:00"
      processStepId="process2"
      laneList="1"
      zoneList="1, 2, 3"
      abortId=”pause23” />
      <Container
            itemType="PalletForProdTT54321"
            <ItemIdentifier
                  idType=”UNIQUE”
                  idCategory=”CONTAINER”
                  identifier="0002"/>
      </Container>
      <Subsystem
            subsystemType="LaserUnit"
            subsystemId="Laser_writer"/>
</ProcessStepAbort>
```

5.9.7.7 Event: ProcessStepComplete

StateChange: No state change

Description: This event indicates the completion of the sub-process. This event must be preceded by a ProcessStepStart message.

ProcessStatus:

OK Process step was finalized successfully

FAILED Process step was executed but it failed or was disturbed.

Attribute / Element Name	Attribute / Element Type	Description	Occurrence
dateTime	dateTime	Date and Time of the event	1-1
processStepId	string	Process step identifier	1-1
laneList	NMTOKENS	Identifies the lane(s)	1-1

zoneList	NMTOKENS	Identifies the zone(s)	1-1
description	string	Human readable description of the event	0-1
processStatus	string (enumerated)	OK | FAILED	0-1
Item	See 5.9.5.1	Identifier of the instance. Item is ABSTRACT element and a head of substitution group. Can be substituted with Container or Component.	0-n
Subsystem	See 4.4.6	Information about a specific subsystem that the process is related	0-1

```
<ProcessStepComplete
      dateTime="2003-03-19T19:50:10.00+03:00"
      processStepId="process2"
      laneList="1"
      zoneList="1-3"
      processStatus="OK"/>
      <Container
            itemType="PalletForProdTT54321"
            <ItemIdentifier
                  idType=”UNIQUE”
                  idCategory=”CONTAINER”
                  identifier="0002"/>
      </Container>
      <Subsystem
            subsystemType="LaserUnit"
            subsystemId="Laser_writer"/>
</ProcessStepComplete>
```

6 THE SPECIFIC ASSEMBLY EQUIPMENT XML-MESSAGE FORMAT

7 EQUIPMENT FLOW EVENT SCENARIOS

7.9 Final Assembly

7.9.1 Equipment Related

1. Equipment runs out of a specific component AND cannot operate. I.e. all material handlers for certain component are empty.
2. Equipment detects an error in a subsystem AND cannot therefore continue processing.
3. A parameter (e.g. temperature, position) has gone over the ALARMLIMITS. The severity of the caution is defined by selecting appropriate message (Alarm, error or warning).
4. A process step is started in the equipment.
5. The process step is paused by equipment or operator.
6. The process step is resumed by equipment or operator.
7. The process step is completed.
8. Equipment generates a report about interesting process parameters.

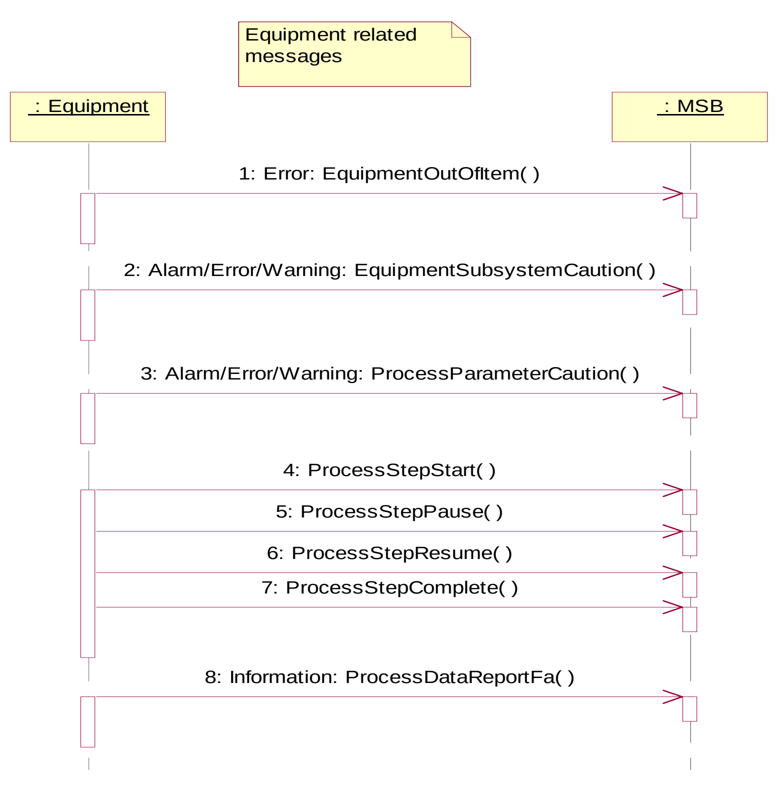


Figure 20 Equipment related message scenarios

7.9.2 Item Related

1. Item (e.g. Container) has not been transferred properly into destination, because of disappearance or jam

2. Equipment was not able to pick a component from the feeder AND the feeder is NOT empty. Possible cause might be a broken End Effector or a jam has occurred.
3. Item (Container or Component) was not recognized, because of barcode or escort memory reading failure; ID is totally missing or wrong item was identified;
4. The item is rejected.
5. Component was picked up and recognized properly BUT it could not meet specifications. e.g. component leg is bended, wrong color;
6. The component is rejected.
7. The component was dropped from the End Effector during the movement to the assembly location or it was placed to a wrong position in the assembly.
8. Product is started to be assembled in the equipment.
9. Item is initialized with data (route, item IDs and properties) or assembly (sub-assembly).
10. New component or sub-assembly has been added (or removed) to certain location in the assembled item.
11. The product has been assembled properly by the equipment.

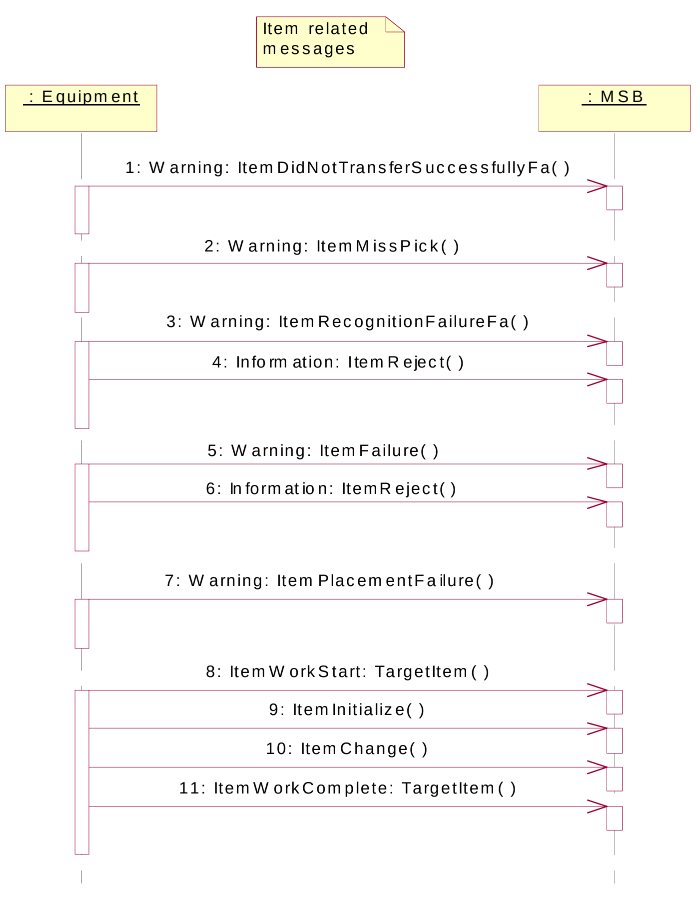


Figure 21 Item related message scenarios

7.9.3 Material Handler Related

All Material handlers (A, B and C) in the example contain similar components.

1. Material handler A has only 20 components left.
2. Material handler A is out of components, but material handler B still has some left.
3. Also, Material handler B runs out of components and;
4. Equipment cannot continue operation due to a lack of components to insert.
5. Material handler A is removed from the equipment to be filled.
6. Material handler B is filled with 100 components.
7. Material handler A is inserted back into equipment;
8. with 200 components.
9. Material handler B jams (= Equipment tries to pick a component, but it cannot AND there are components left in material handler)
10. Material handler B is removed
11. A new material handler C is replacing the Material handler B in the equipment;
12. with 0 components.
13. Material handler A is removed from Equipment AND;
14. Material handler A is out of components AND;
15. Equipment gets also out of components

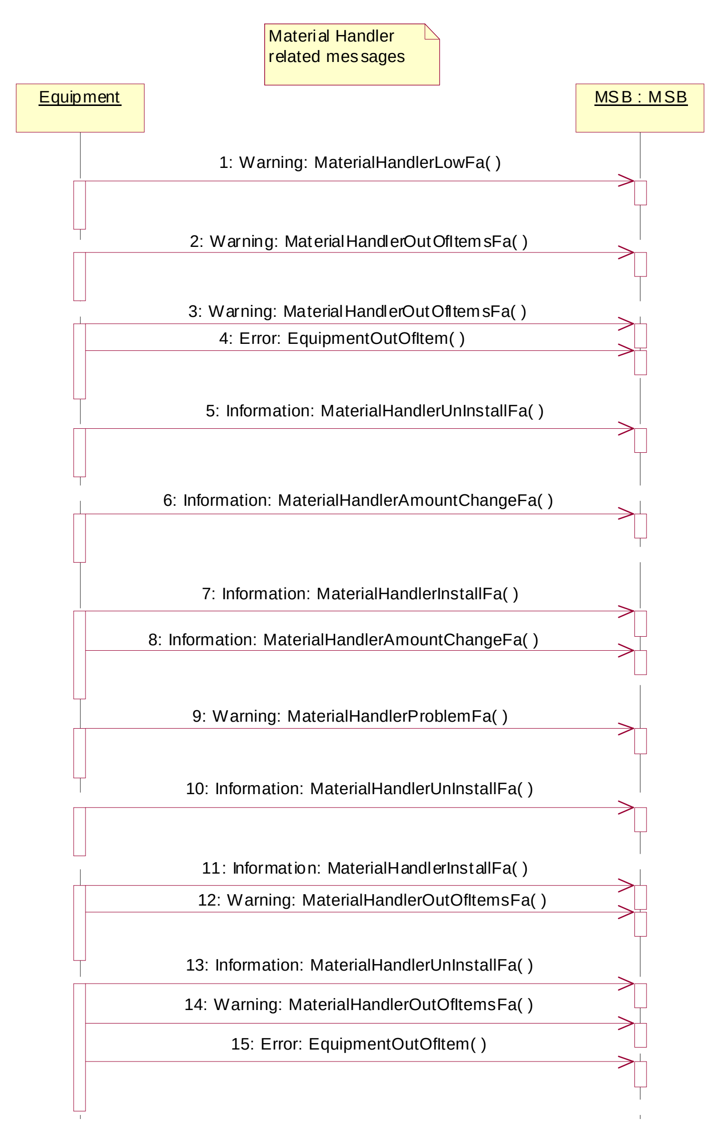


Figure 22 Material handler related message scenarios

8 2546 XML SCHEMAS

8.0 Generic for all specific sections of IPC-2546

8.0.1 Component library schema for IPC-2546

URL: http://webstds.ipc.org/2546/Component_lib_IPC-2546.xsd

Extends: -

Includes: -

Schema:

```
<?xml version = "1.0" encoding = "UTF-8"?>
<xs:schema xmlns:xs = "http://www.w3.org/2001/XMLSchema"
    elementFormDefault = "qualified"
    attributeFormDefault = "unqualified">

    <!--IPC2546 General: Simple Types-->
    <xs:simpleType name = "IMAGE_TYPE">
        <xs:restriction base = "xs:string">
            <xs:enumeration value = "LOCAL"/>
            <xs:enumeration value = "GLOBAL"/>
        </xs:restriction>
    </xs:simpleType>
```

Graphical Representation:

BadBoardMark
imageId string
designator string
imageType IMAGE_TYPE

Schema (cont.):

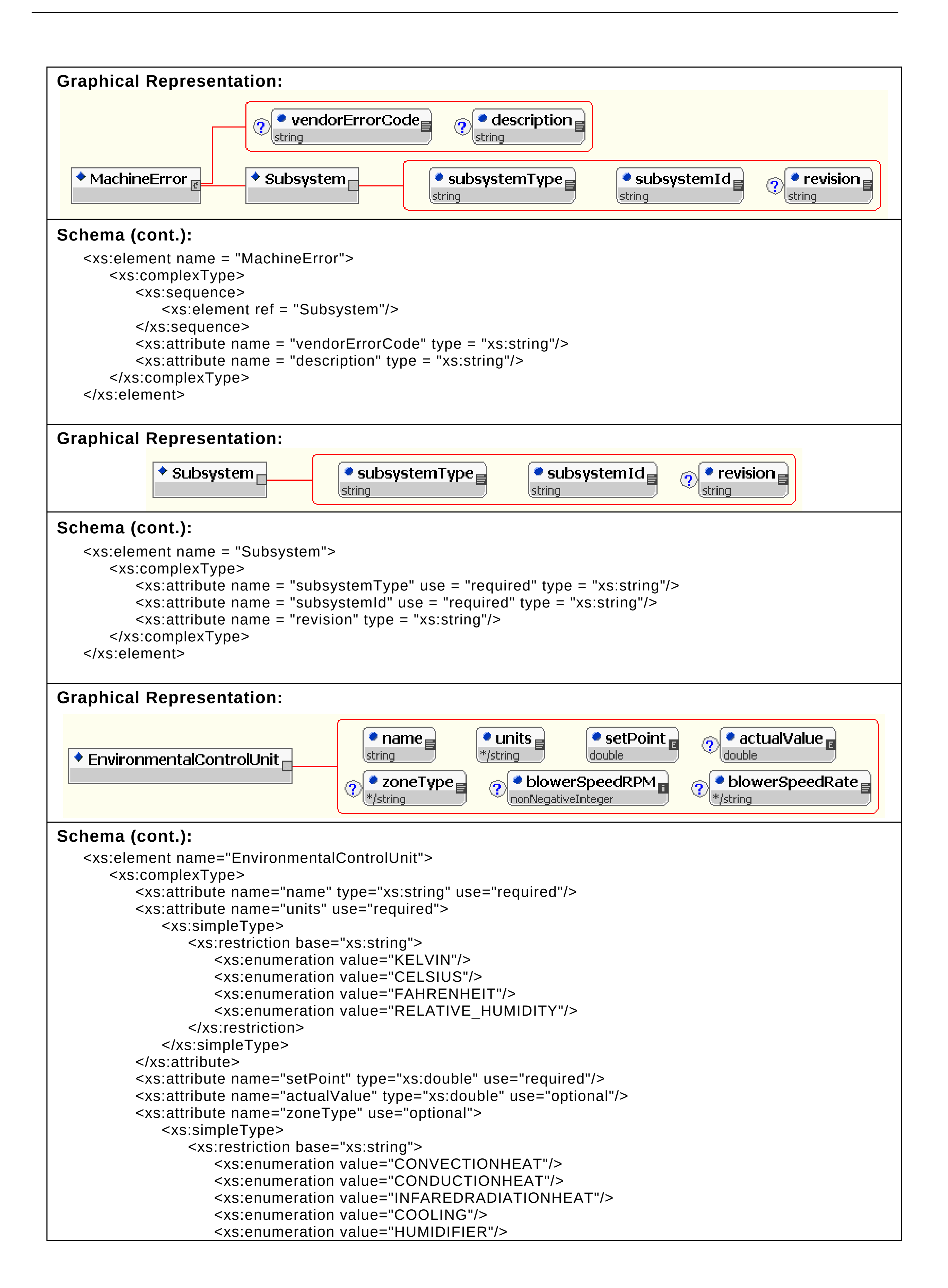
```
    <!--NestedElements from IPC2546 General-->
    <xs:element name = "BadBoardMark">
        <xs:complexType>
            <xs:attribute name = "imageId" use = "required" type = "xs:string"/>
            <xs:attribute name = "designator" type = "xs:string"/>
            <xs:attribute name = "imageType" type = "IMAGE_TYPE"/>
        </xs:complexType>
    </xs:element>
```

Graphical Representation:

Fiducial
designator string
imageId string
imageType IMAGE_TYPE
imageShape string
recognitionReference string
score positiveInteger

Schema (cont.):

```
    <xs:element name = "Fiducial">
        <xs:complexType>
            <xs:attribute name = "designator" use = "required" type = "xs:string"/>
            <xs:attribute name = "imageId" type = "xs:string"/>
            <xs:attribute name = "imageType" type = "IMAGE_TYPE"/>
            <xs:attribute name = "imageShape" type = "xs:string"/>
            <xs:attribute name = "recognitionReference" type = "xs:string"/>
            <xs:attribute name = "score" type = "xs:positiveInteger"/>
        </xs:complexType>
    </xs:element>
```



Graphical Representation:

Schema (cont.):

```
<xs:element name = "MachineError">
    <xs:complexType>
        <xs:sequence>
            <xs:element ref = "Subsystem"/>
        </xs:sequence>
        <xs:attribute name = "vendorErrorCode" type = "xs:string"/>
        <xs:attribute name = "description" type = "xs:string"/>
    </xs:complexType>
</xs:element>
```

Graphical Representation:

Schema (cont.):

```
<xs:element name = "Subsystem">
    <xs:complexType>
        <xs:attribute name = "subsystemType" use = "required" type = "xs:string"/>
        <xs:attribute name = "subsystemId" use = "required" type = "xs:string"/>
        <xs:attribute name = "revision" type = "xs:string"/>
    </xs:complexType>
</xs:element>
```

Graphical Representation:

Schema (cont.):

```
<xs:element name="EnvironmentalControlUnit">
    <xs:complexType>
        <xs:attribute name="name" type="xs:string" use="required"/>
        <xs:attribute name="units" use="required">
            <xs:simpleType>
                <xs:restriction base="xs:string">
                    <xs:enumeration value="KELVIN"/>
                    <xs:enumeration value="CELSIUS"/>
                    <xs:enumeration value="FAHRENHEIT"/>
                    <xs:enumeration value="RELATIVE_HUMIDITY"/>
                </xs:restriction>
            </xs:simpleType>
        </xs:attribute>
        <xs:attribute name="setPoint" type="xs:double" use="required"/>
        <xs:attribute name="actualValue" type="xs:double" use="optional"/>
        <xs:attribute name="zoneType" use="optional">
            <xs:simpleType>
                <xs:restriction base="xs:string">
                    <xs:enumeration value="CONVECTIONHEAT"/>
                    <xs:enumeration value="CONDUCTIONHEAT"/>
                    <xs:enumeration value="INFAREDRADIATIONHEAT"/>
                    <xs:enumeration value="COOLING"/>
                    <xs:enumeration value="HUMIDIFIER"/>
```

```
                </xs:restriction>
            </xs:simpleType>
        </xs:attribute>
        <xs:attribute name="blowerSpeedRPM" type="xs:nonNegativeInteger" use="optional"/>
        <xs:attribute name="blowerSpeedRate" use="optional">
            <xs:simpleType>
                <xs:restriction base="xs:string">
                    <xs:enumeration value="LOW"/>
                    <xs:enumeration value="MEDLOW"/>
                    <xs:enumeration value="MED"/>
                    <xs:enumeration value="MEDHIGH"/>
                    <xs:enumeration value="HIGH"/>
                </xs:restriction>
            </xs:simpleType>
        </xs:attribute>
    </xs:complexType>
</xs:element>
```

Graphical Representation:

ItemData — itemMultiplier (nonNegativeInteger) — units (*/string) — itemLength (double) — itemWidth (double)

Schema (cont.):

```
<xs:element name="ItemData">
    <xs:complexType>
        <xs:attribute name="itemMultiplier" type="xs:nonNegativeInteger" use="optional"/>
        <xs:attribute name="units" use="optional">
            <xs:simpleType>
                <xs:restriction base="xs:string">
                    <xs:enumeration value="METER"/>
                    <xs:enumeration value="INCH"/>
                </xs:restriction>
            </xs:simpleType>
        </xs:attribute>
        <xs:attribute name="itemLength" type="xs:double" use="optional"/>
        <xs:attribute name="itemWidth" type="xs:double" use="optional"/>
    </xs:complexType>
</xs:element>
```

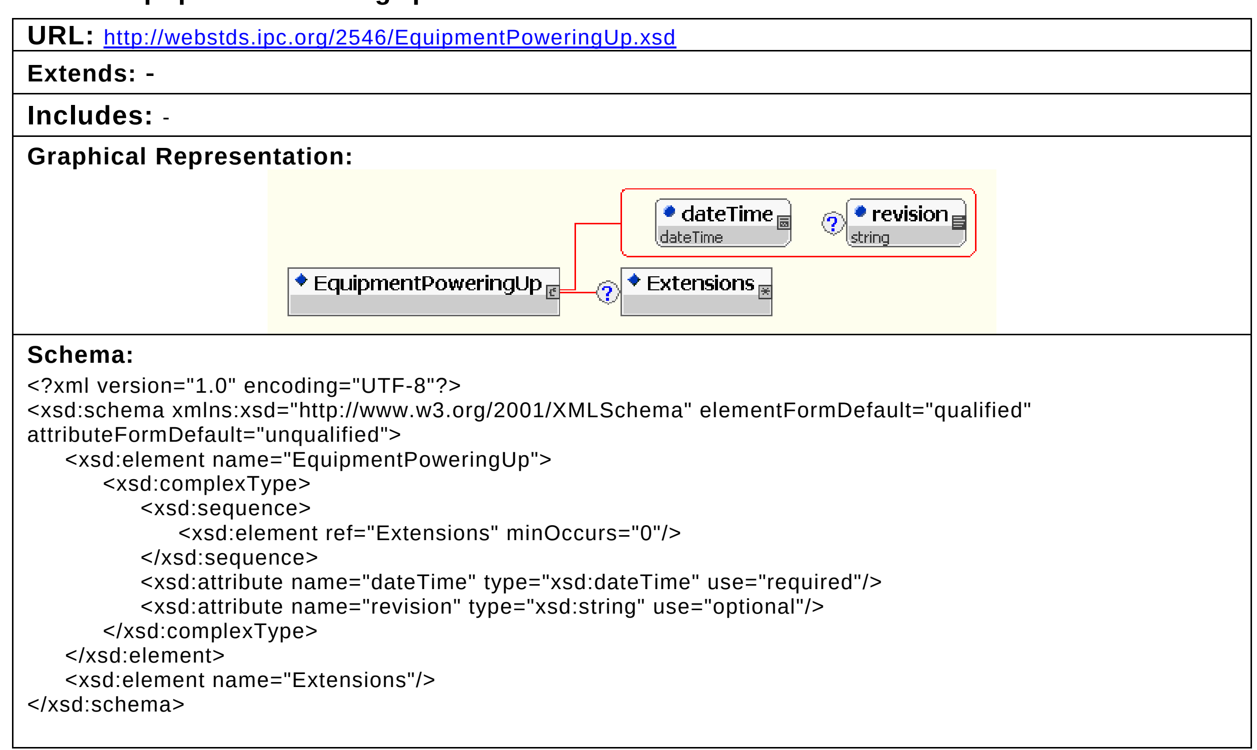
Graphical Representation:

Extensions — #wildCard

Schema (cont.):

```
<xs:element name = "Extensions">
    <xs:complexType>
        <xs:sequence>
            <xs:any namespace = "##any" processContents = "strict" minOccurs = "0" maxOccurs =
"unbounded"/>
        </xs:sequence>
    </xs:complexType>
</xs:element>
</xs:schema>
```

8.0.2 EquipmentPoweringUp



URL: http://webstds.ipc.org/2546/EquipmentPoweringUp.xsd

Extends: -

Includes: -

Graphical Representation:

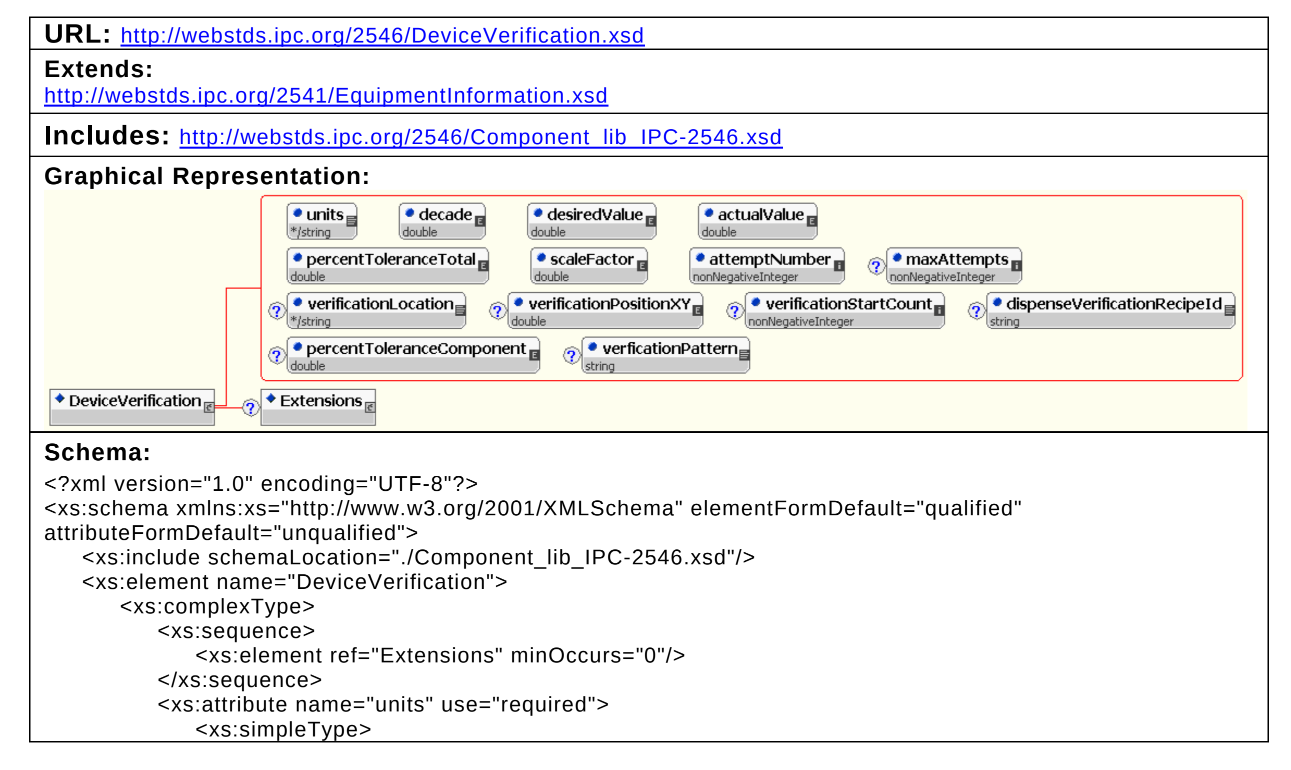
Schema:

```
<?xml version="1.0" encoding="UTF-8"?>
<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified"
attributeFormDefault="unqualified">
    <xsd:element name="EquipmentPoweringUp">
        <xsd:complexType>
            <xsd:sequence>
                <xsd:element ref="Extensions" minOccurs="0"/>
            </xsd:sequence>
            <xsd:attribute name="dateTime" type="xsd:dateTime" use="required"/>
            <xsd:attribute name="revision" type="xsd:string" use="optional"/>
        </xsd:complexType>
    </xsd:element>
    <xsd:element name="Extensions"/>
</xsd:schema>
```

8.1 Screen Printing Specific

8.2 Dispensing Specific

8.2.1 DeviceVerification



URL: http://webstds.ipc.org/2546/DeviceVerification.xsd

Extends: http://webstds.ipc.org/2541/EquipmentInformation.xsd

Includes: http://webstds.ipc.org/2546/Component_lib_IPC-2546.xsd

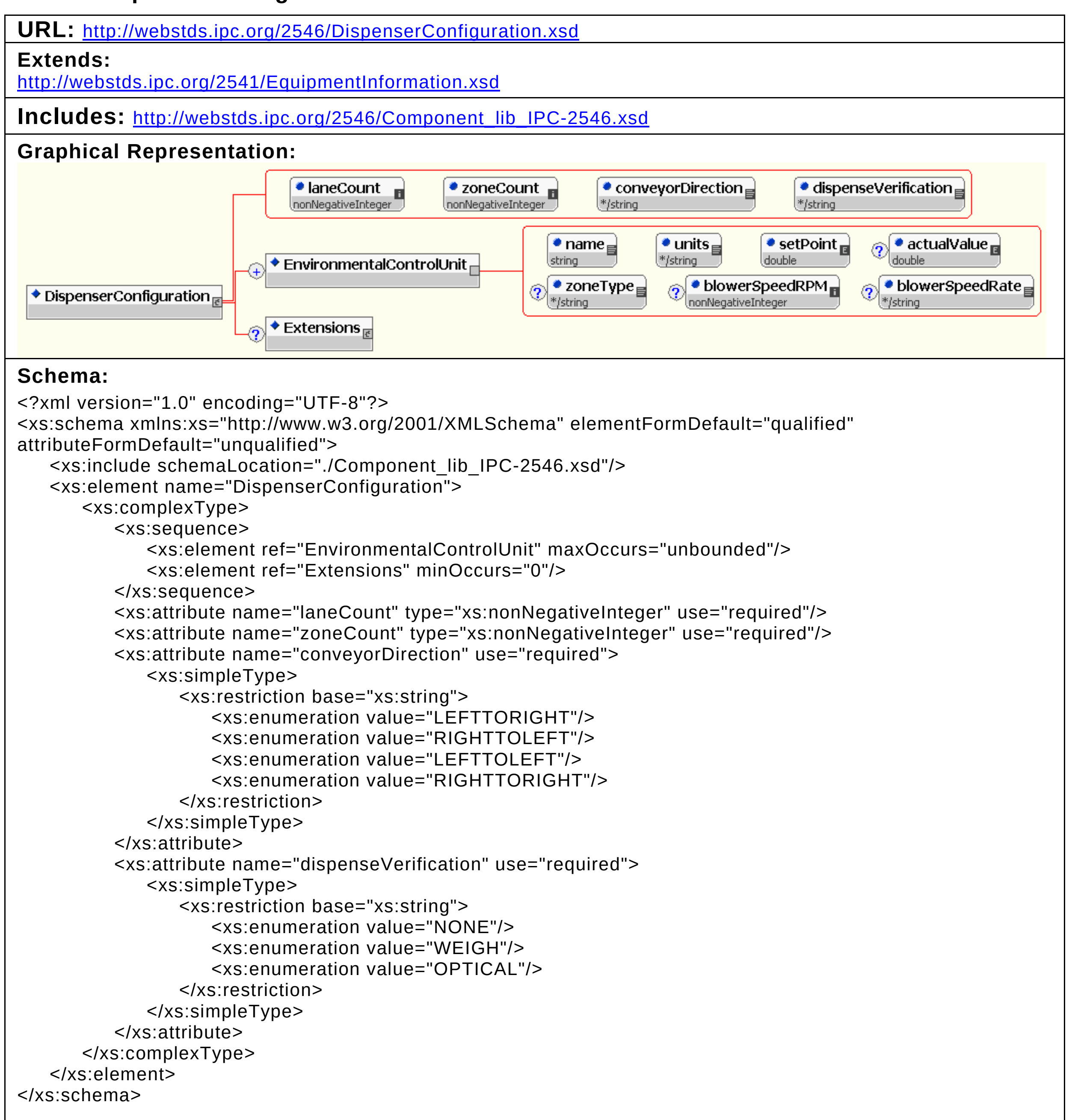
Graphical Representation:

Schema:

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified"
attributeFormDefault="unqualified">
    <xs:include schemaLocation="./Component_lib_IPC-2546.xsd"/>
    <xs:element name="DeviceVerification">
        <xs:complexType>
            <xs:sequence>
                <xs:element ref="Extensions" minOccurs="0"/>
            </xs:sequence>
            <xs:attribute name="units" use="required">
                <xs:simpleType>
```

```
                    <xs:restriction base="xs:string">
                        <xs:enumeration value="OUNCE"/>
                        <xs:enumeration value="KILOGRAM"/>
                        <xs:enumeration value="METER"/>
                        <xs:enumeration value="METER^2"/>
                        <xs:enumeration value="METER^3"/>
                        <xs:enumeration value="INCH"/>
                        <xs:enumeration value="INCH^2"/>
                        <xs:enumeration value="INCH^3"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:attribute>
            <xs:attribute name="decade" type="xs:double" use="required"/>
            <xs:attribute name="desiredValue" type="xs:double" use="required"/>
            <xs:attribute name="actualValue" type="xs:double" use="required"/>
            <xs:attribute name="percentToleranceTotal" type="xs:double" use="required"/>
            <xs:attribute name="scaleFactor" type="xs:double" use="required"/>
            <xs:attribute name="attemptNumber" type="xs:nonNegativeInteger" use="required"/>
            <xs:attribute name="maxAttempts" type="xs:nonNegativeInteger" use="optional"/>
            <xs:attribute name="verificationLocation" use="optional">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:enumeration value="ITEM"/>
                        <xs:enumeration value="FIXED"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:attribute>
            <xs:attribute name="verificationPositionXY" type="xs:double" use="optional"/>
            <xs:attribute name="verificationStartCount" type="xs:nonNegativeInteger" use="optional"/>
            <xs:attribute name="dispenseVerificationRecipeId" type="xs:string" use="optional"/>
            <xs:attribute name="percentToleranceComponent" type="xs:double" use="optional"/>
            <xs:attribute name="verficationPattern" type="xs:string" use="optional"/>
        </xs:complexType>
    </xs:element>
</xs:schema>
```

8.2.2 DispenserConfiguration



URL: http://webstds.ipc.org/2546/DispenserConfiguration.xsd

Extends:
http://webstds.ipc.org/2541/EquipmentInformation.xsd

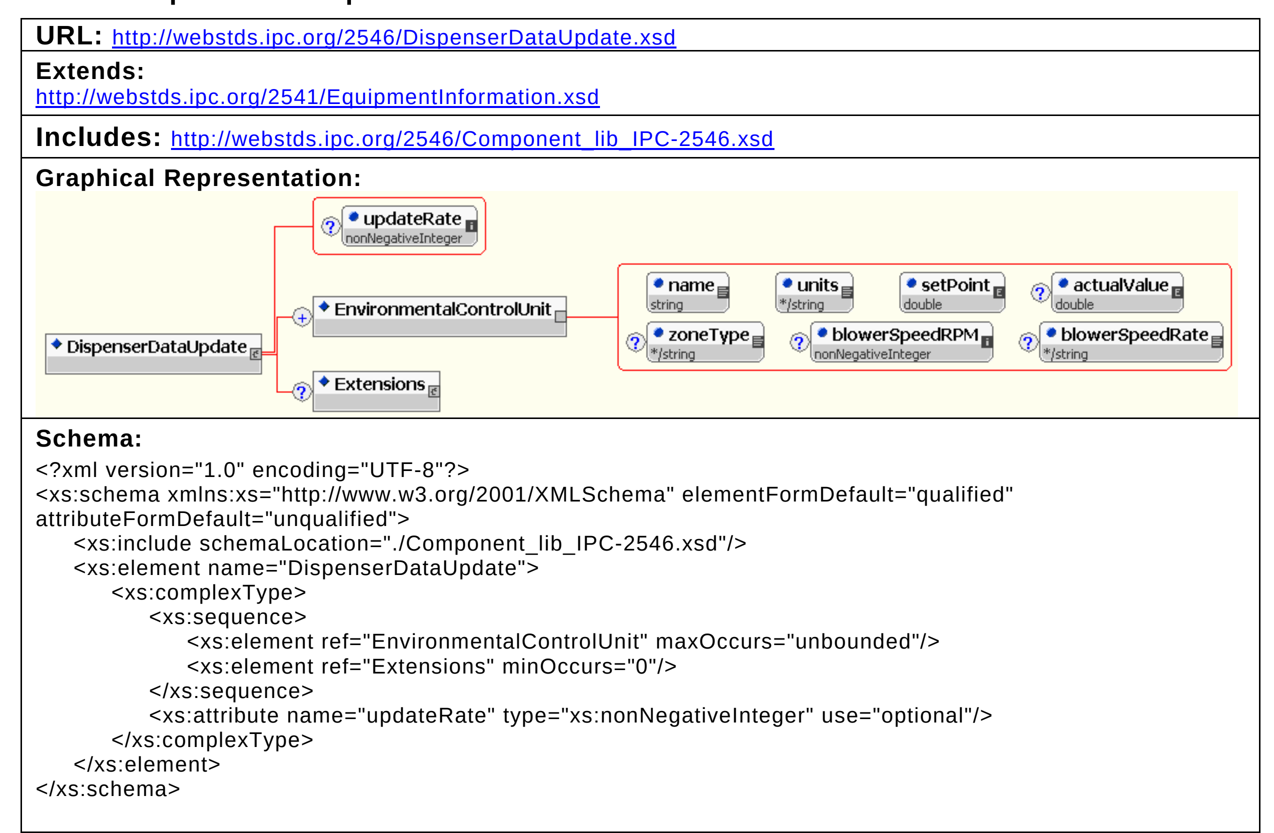
Includes: http://webstds.ipc.org/2546/Component_lib_IPC-2546.xsd

Graphical Representation:

Schema:

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified"
attributeFormDefault="unqualified">
    <xs:include schemaLocation="./Component_lib_IPC-2546.xsd"/>
    <xs:element name="DispenserConfiguration">
        <xs:complexType>
            <xs:sequence>
                <xs:element ref="EnvironmentalControlUnit" maxOccurs="unbounded"/>
                <xs:element ref="Extensions" minOccurs="0"/>
            </xs:sequence>
            <xs:attribute name="laneCount" type="xs:nonNegativeInteger" use="required"/>
            <xs:attribute name="zoneCount" type="xs:nonNegativeInteger" use="required"/>
            <xs:attribute name="conveyorDirection" use="required">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:enumeration value="LEFTTORIGHT"/>
                        <xs:enumeration value="RIGHTTOLEFT"/>
                        <xs:enumeration value="LEFTTOLEFT"/>
                        <xs:enumeration value="RIGHTTORIGHT"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:attribute>
            <xs:attribute name="dispenseVerification" use="required">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:enumeration value="NONE"/>
                        <xs:enumeration value="WEIGH"/>
                        <xs:enumeration value="OPTICAL"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:attribute>
        </xs:complexType>
    </xs:element>
</xs:schema>
```

8.2.3 DispenserDataUpdate



URL: http://webstds.ipc.org/2546/DispenserDataUpdate.xsd

Extends: http://webstds.ipc.org/2541/EquipmentInformation.xsd

Includes: http://webstds.ipc.org/2546/Component_lib_IPC-2546.xsd

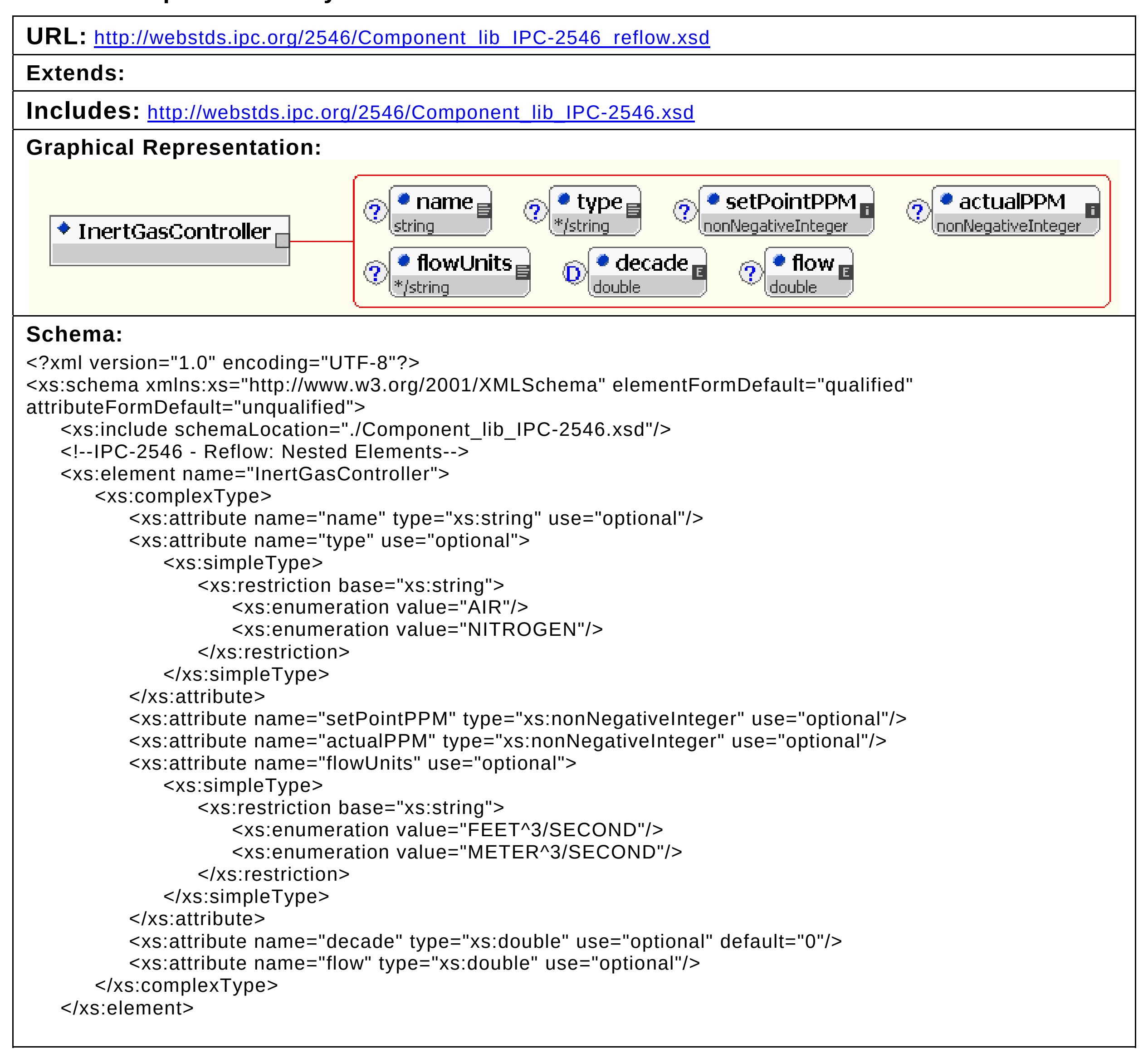
Graphical Representation:

Schema:

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified"
attributeFormDefault="unqualified">
    <xs:include schemaLocation="./Component_lib_IPC-2546.xsd"/>
    <xs:element name="DispenserDataUpdate">
        <xs:complexType>
            <xs:sequence>
                <xs:element ref="EnvironmentalControlUnit" maxOccurs="unbounded"/>
                <xs:element ref="Extensions" minOccurs="0"/>
            </xs:sequence>
            <xs:attribute name="updateRate" type="xs:nonNegativeInteger" use="optional"/>
        </xs:complexType>
    </xs:element>
</xs:schema>
```

8.3 Reflow specific

8.3.1 Component library schema for IPC-2546/Reflow



URL: http://webstds.ipc.org/2546/Component_lib_IPC-2546_reflow.xsd

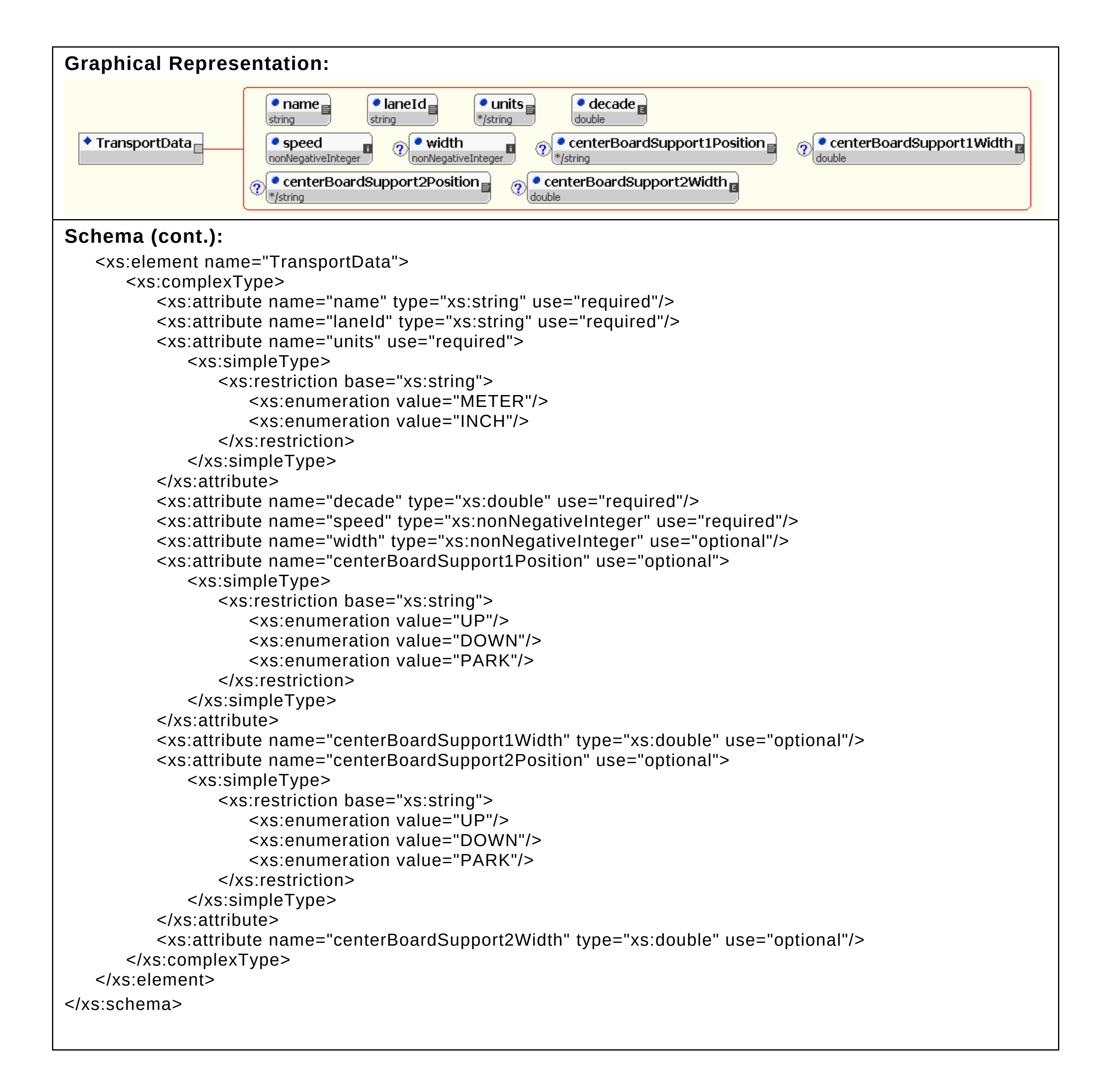
Extends:

Includes: http://webstds.ipc.org/2546/Component_lib_IPC-2546.xsd

Graphical Representation:

Schema:

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified"
attributeFormDefault="unqualified">
    <xs:include schemaLocation="./Component_lib_IPC-2546.xsd"/>
    <!--IPC-2546 - Reflow: Nested Elements-->
    <xs:element name="InertGasController">
        <xs:complexType>
            <xs:attribute name="name" type="xs:string" use="optional"/>
            <xs:attribute name="type" use="optional">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:enumeration value="AIR"/>
                        <xs:enumeration value="NITROGEN"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:attribute>
            <xs:attribute name="setPointPPM" type="xs:nonNegativeInteger" use="optional"/>
            <xs:attribute name="actualPPM" type="xs:nonNegativeInteger" use="optional"/>
            <xs:attribute name="flowUnits" use="optional">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:enumeration value="FEET^3/SECOND"/>
                        <xs:enumeration value="METER^3/SECOND"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:attribute>
            <xs:attribute name="decade" type="xs:double" use="optional" default="0"/>
            <xs:attribute name="flow" type="xs:double" use="optional"/>
        </xs:complexType>
    </xs:element>
```



Graphical Representation:

Schema (cont.):

```
    <xs:element name="TransportData">
        <xs:complexType>
            <xs:attribute name="name" type="xs:string" use="required"/>
            <xs:attribute name="laneId" type="xs:string" use="required"/>
            <xs:attribute name="units" use="required">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:enumeration value="METER"/>
                        <xs:enumeration value="INCH"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:attribute>
            <xs:attribute name="decade" type="xs:double" use="required"/>
            <xs:attribute name="speed" type="xs:nonNegativeInteger" use="required"/>
            <xs:attribute name="width" type="xs:nonNegativeInteger" use="optional"/>
            <xs:attribute name="centerBoardSupport1Position" use="optional">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:enumeration value="UP"/>
                        <xs:enumeration value="DOWN"/>
                        <xs:enumeration value="PARK"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:attribute>
            <xs:attribute name="centerBoardSupport1Width" type="xs:double" use="optional"/>
            <xs:attribute name="centerBoardSupport2Position" use="optional">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:enumeration value="UP"/>
                        <xs:enumeration value="DOWN"/>
                        <xs:enumeration value="PARK"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:attribute>
            <xs:attribute name="centerBoardSupport2Width" type="xs:double" use="optional"/>
        </xs:complexType>
    </xs:element>
</xs:schema>
```

8.3.2 ReflowConfiguration

URL: http://webstds.ipc.org/2546/ReflowConfiguration.xsd

Extends: http://webstds.ipc.org/2541/EquipmentInformation.xsd

Includes: http://webstds.ipc.org/2546/Component_lib_IPC-2546_reflow.xsd

Graphical Representation:

laneCount nonNegativeInteger
zoneCount nonNegativeInteger
transportDirection */string
highTemp boolean
gasType */string
additionalCooling boolean
fluxExtraction boolean
transportType */string
autoWidthAdjust boolean
smema boolean
centerBoardSupport boolean
ReflowConfiguration
Extensions

Schema:

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified"
attributeFormDefault="unqualified">
    <xs:include schemaLocation="./Component_lib_IPC-2546_reflow.xsd"/>
    <xs:element name="ReflowConfiguration">
        <xs:complexType>
            <xs:sequence>
                <xs:element ref="Extensions" minOccurs="0"/>
            </xs:sequence>
            <xs:attribute name="laneCount" type="xs:nonNegativeInteger" use="required"/>
            <xs:attribute name="zoneCount" type="xs:nonNegativeInteger" use="required"/>
            <xs:attribute name="transportDirection" use="required">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:enumeration value="LEFTTORIGHT"/>
                        <xs:enumeration value="RIGHTTOLEFT"/>
                        <xs:enumeration value="LEFTTOLEFT"/>
                        <xs:enumeration value="RIGHTTORIGHT"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:attribute>
            <xs:attribute name="highTemp" type="xs:boolean" use="required"/>
            <xs:attribute name="gasType" use="required">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:enumeration value="AIR"/>
                        <xs:enumeration value="NITROGEN"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:attribute>
            <xs:attribute name="additionalCooling" type="xs:boolean" use="required"/>
            <xs:attribute name="fluxExtraction" type="xs:boolean" use="required"/>
            <xs:attribute name="transportType" use="required">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:enumeration value="BELT"/>
                        <xs:enumeration value="RAIL"/>
                        <xs:enumeration value="COMBINATION"/>
                        <xs:enumeration value="DUALLANE"/>
                        <xs:enumeration value="DUALLANESINGLEBELT"/>
                        <xs:enumeration value="TRIPLELANE"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:attribute>
            <xs:attribute name="autoWidthAdjust" type="xs:boolean" use="required"/>
            <xs:attribute name="smema" type="xs:boolean" use="required"/>
            <xs:attribute name="centerBoardSupport" type="xs:boolean" use="required"/>
        </xs:complexType>
    </xs:element>
</xs:schema>
```

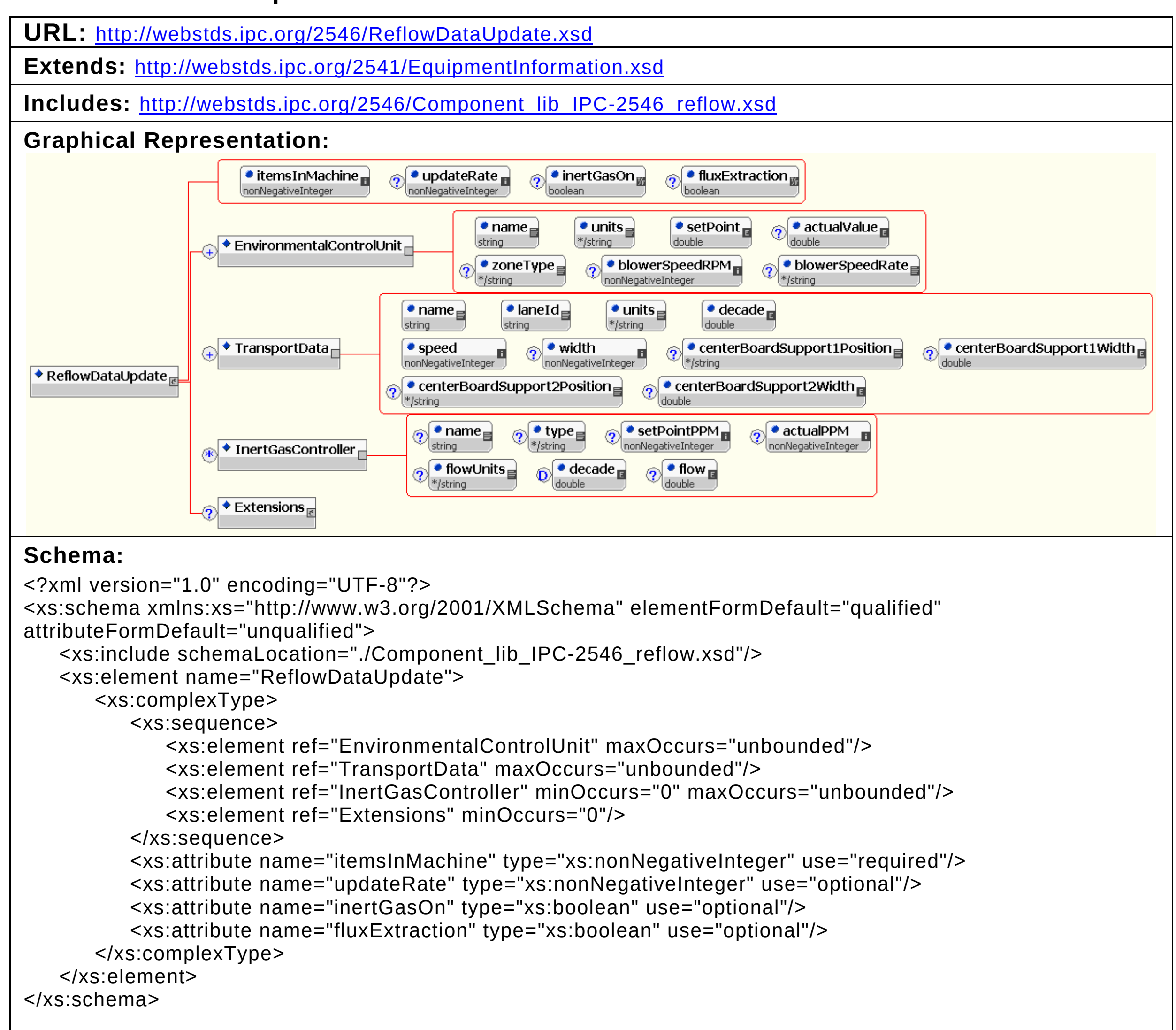
8.3.3 ReflowDataUpdate

URL: http://webstds.ipc.org/2546/ReflowDataUpdate.xsd

Extends: http://webstds.ipc.org/2541/EquipmentInformation.xsd

Includes: http://webstds.ipc.org/2546/Component_lib_IPC-2546_reflow.xsd

Graphical Representation:



Schema:

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified"
attributeFormDefault="unqualified">
    <xs:include schemaLocation="./Component_lib_IPC-2546_reflow.xsd"/>
    <xs:element name="ReflowDataUpdate">
        <xs:complexType>
            <xs:sequence>
                <xs:element ref="EnvironmentalControlUnit" maxOccurs="unbounded"/>
                <xs:element ref="TransportData" maxOccurs="unbounded"/>
                <xs:element ref="InertGasController" minOccurs="0" maxOccurs="unbounded"/>
                <xs:element ref="Extensions" minOccurs="0"/>
            </xs:sequence>
            <xs:attribute name="itemsInMachine" type="xs:nonNegativeInteger" use="required"/>
            <xs:attribute name="updateRate" type="xs:nonNegativeInteger" use="optional"/>
            <xs:attribute name="inertGasOn" type="xs:boolean" use="optional"/>
            <xs:attribute name="fluxExtraction" type="xs:boolean" use="optional"/>
        </xs:complexType>
    </xs:element>
</xs:schema>
```

8.4 Pick and Place Specific

Increase the title level for the schemas from Heading 2 to Heading 3

8.4.1 EquipmentOutOfComponent

8.4.2 EquipmentErrorSubsystem

8.4.3 ItemRecognitionFailure

8.4.4 ItemDidNotTransferSuccessfully

8.4.5 MaterialHandlerLow

8.4.6 MaterialHandlerInstalled

8.4.7 MaterialHandlerUnInstalled

8.4.8 MaterialHandlerDivisionDown

8.4.9 MaterialHandlerTrouble

8.4.10 MaterialHandlerOutOfComponent

8.4.11 ComponentMisPick

8.4.12 ComponentNotPlaced

8.4.13 MaterialHandlerChanged

8.4.14 ComponentNotRecognized

8.4.15 MaterialHandlerTableInstalled

8.4.16 MaterialHandlerTableUnInstalled

8.4.17 MaterialHandlerDivisionUp

8.4.18 MaterialHandlerRefilled

8.4.19 ComponentReject

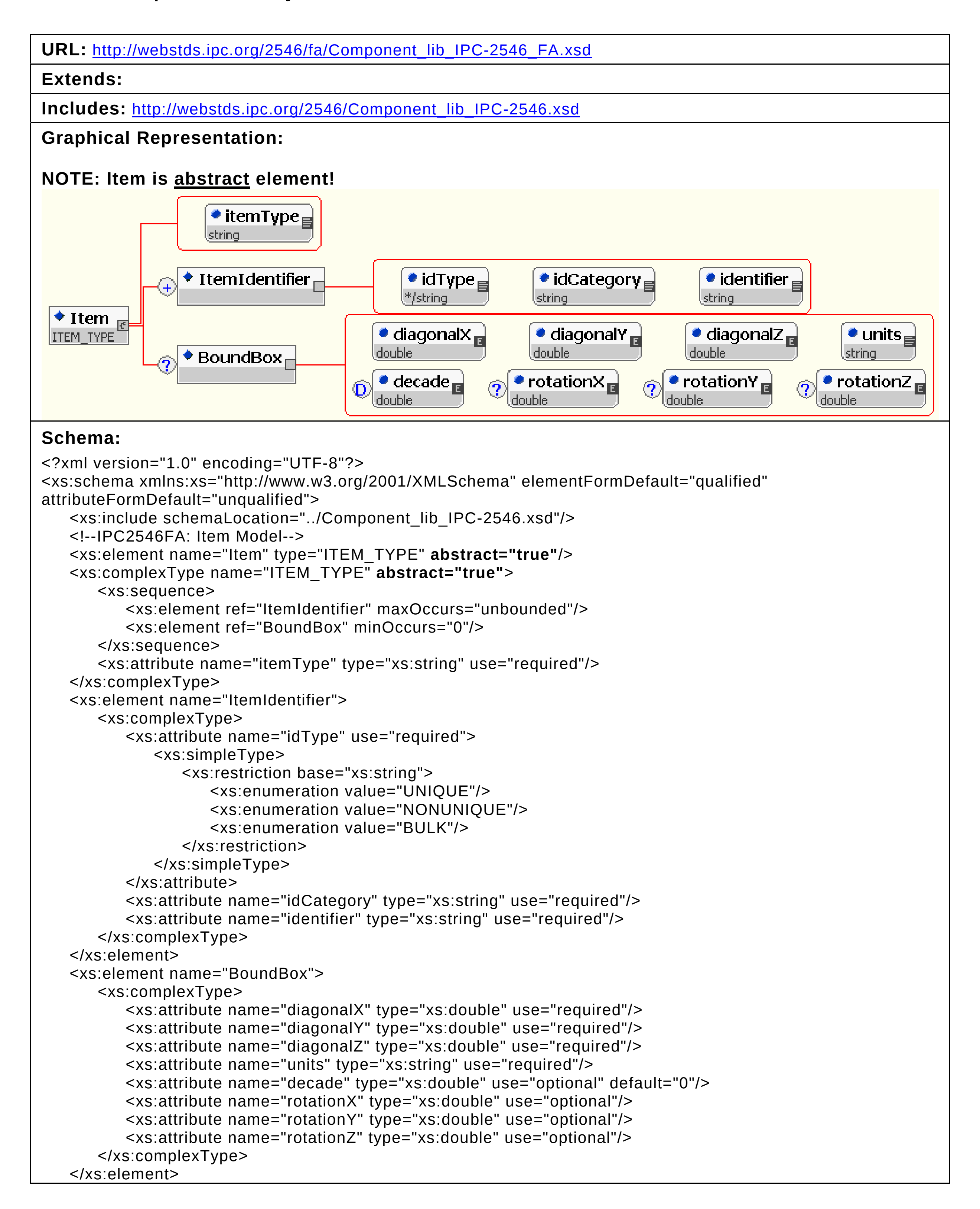
8.6 Plated through hole placement

8.7 Solder reflowing

8.8 Wave soldering

8.9 Final Assembly and Packaging Specific

8.9.1 Component library schema for IPC-2546/FA



URL: http://webstds.ipc.org/2546/fa/Component_lib_IPC-2546_FA.xsd

Extends:

Includes: http://webstds.ipc.org/2546/Component_lib_IPC-2546.xsd

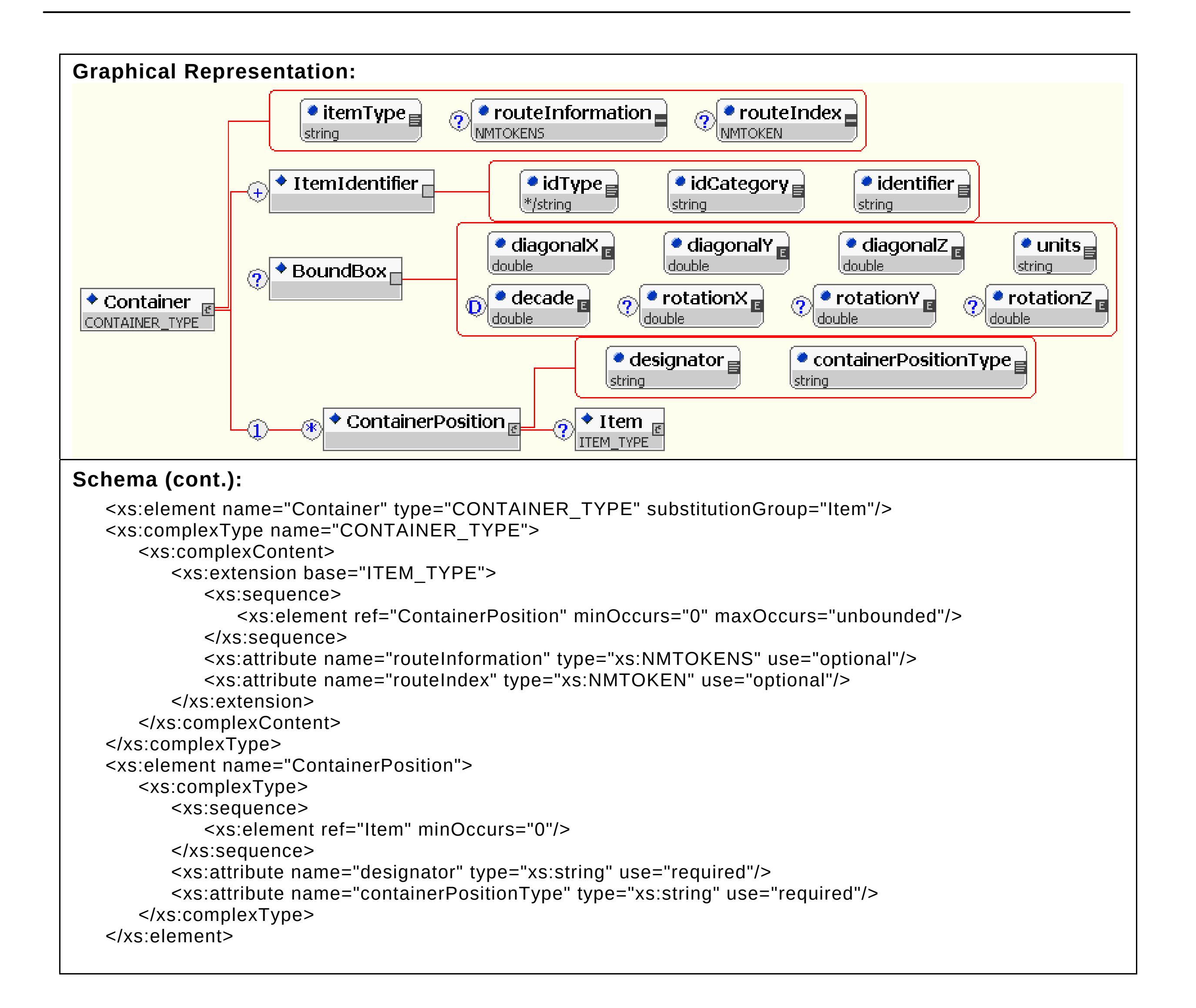
Graphical Representation:

NOTE: Item is abstract element!

Schema:

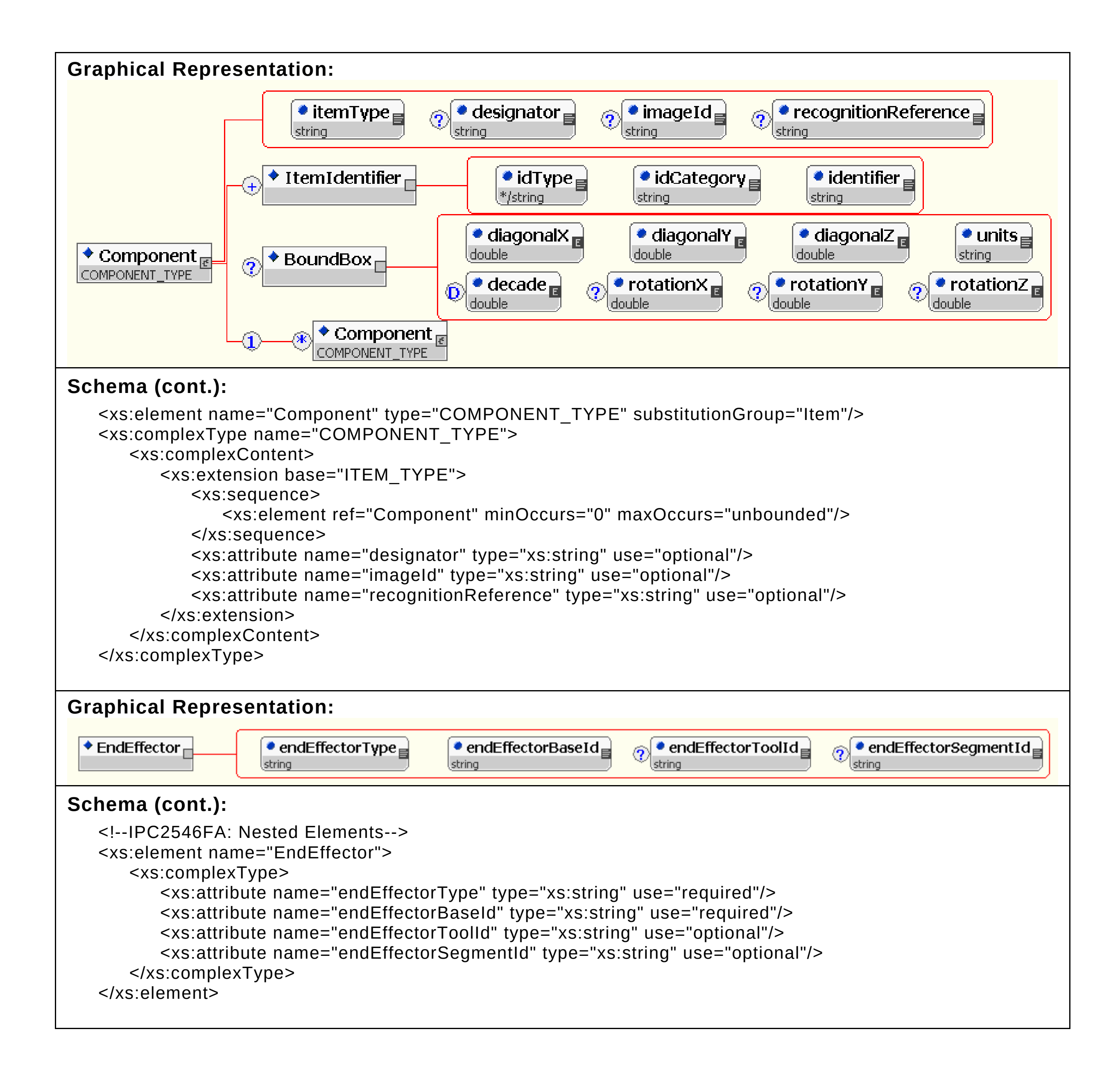
```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified"
attributeFormDefault="unqualified">
    <xs:include schemaLocation="../Component_lib_IPC-2546.xsd"/>
    <!--IPC2546FA: Item Model-->
    <xs:element name="Item" type="ITEM_TYPE" abstract="true"/>
    <xs:complexType name="ITEM_TYPE" abstract="true">
        <xs:sequence>
            <xs:element ref="ItemIdentifier" maxOccurs="unbounded"/>
            <xs:element ref="BoundBox" minOccurs="0"/>
        </xs:sequence>
        <xs:attribute name="itemType" type="xs:string" use="required"/>
    </xs:complexType>
    <xs:element name="ItemIdentifier">
        <xs:complexType>
            <xs:attribute name="idType" use="required">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:enumeration value="UNIQUE"/>
                        <xs:enumeration value="NONUNIQUE"/>
                        <xs:enumeration value="BULK"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:attribute>
            <xs:attribute name="idCategory" type="xs:string" use="required"/>
            <xs:attribute name="identifier" type="xs:string" use="required"/>
        </xs:complexType>
    </xs:element>
    <xs:element name="BoundBox">
        <xs:complexType>
            <xs:attribute name="diagonalX" type="xs:double" use="required"/>
            <xs:attribute name="diagonalY" type="xs:double" use="required"/>
            <xs:attribute name="diagonalZ" type="xs:double" use="required"/>
            <xs:attribute name="units" type="xs:string" use="required"/>
            <xs:attribute name="decade" type="xs:double" use="optional" default="0"/>
            <xs:attribute name="rotationX" type="xs:double" use="optional"/>
            <xs:attribute name="rotationY" type="xs:double" use="optional"/>
            <xs:attribute name="rotationZ" type="xs:double" use="optional"/>
        </xs:complexType>
    </xs:element>
```

Graphical Representation:



Schema (cont.):

```
<xs:element name="Container" type="CONTAINER_TYPE" substitutionGroup="Item"/>
<xs:complexType name="CONTAINER_TYPE">
    <xs:complexContent>
        <xs:extension base="ITEM_TYPE">
            <xs:sequence>
                <xs:element ref="ContainerPosition" minOccurs="0" maxOccurs="unbounded"/>
            </xs:sequence>
            <xs:attribute name="routeInformation" type="xs:NMTOKENS" use="optional"/>
            <xs:attribute name="routeIndex" type="xs:NMTOKEN" use="optional"/>
        </xs:extension>
    </xs:complexContent>
</xs:complexType>
<xs:element name="ContainerPosition">
    <xs:complexType>
        <xs:sequence>
            <xs:element ref="Item" minOccurs="0"/>
        </xs:sequence>
        <xs:attribute name="designator" type="xs:string" use="required"/>
        <xs:attribute name="containerPositionType" type="xs:string" use="required"/>
    </xs:complexType>
</xs:element>
```



Graphical Representation:

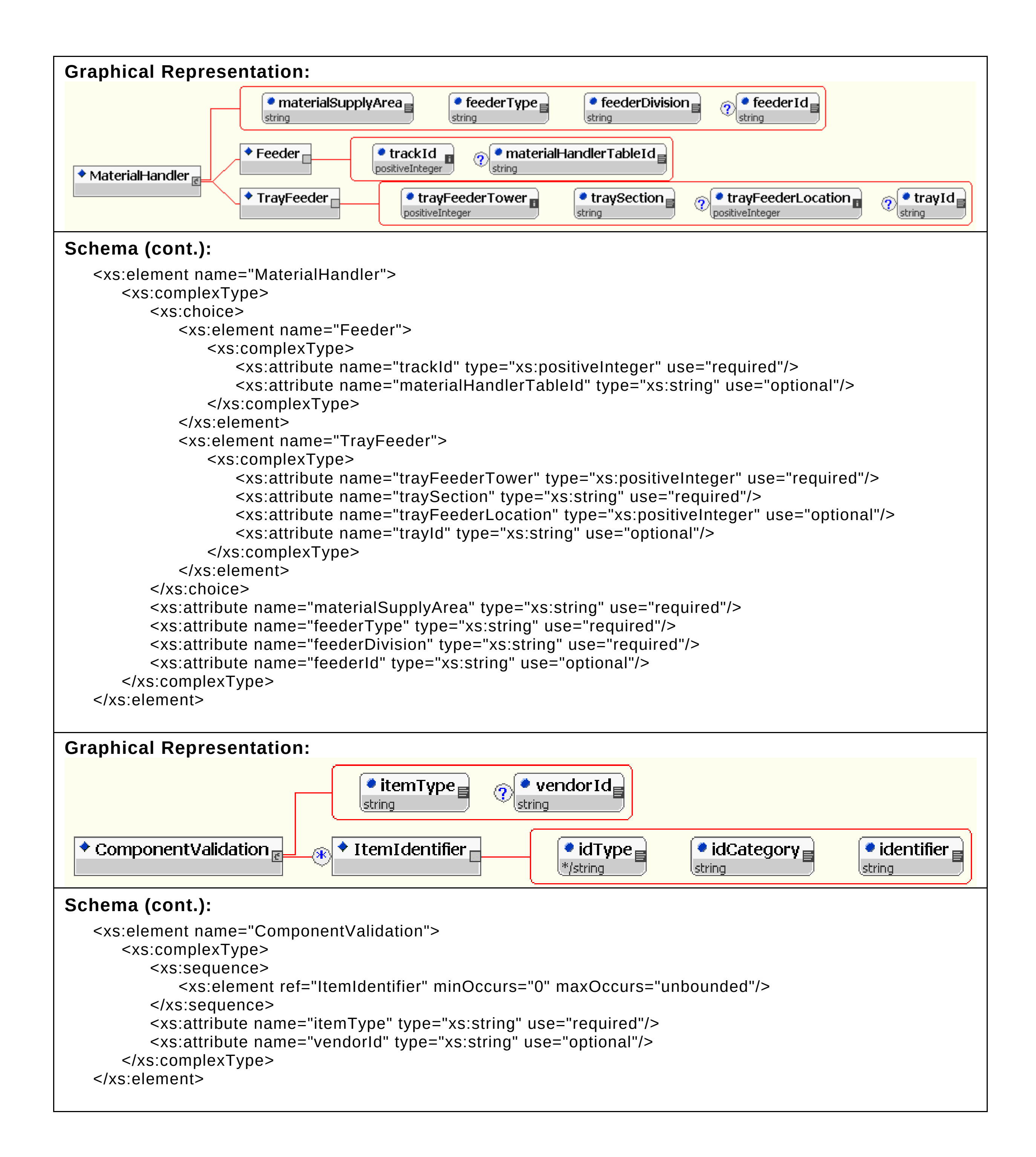
Schema (cont.):

```
<xs:element name="Component" type="COMPONENT_TYPE" substitutionGroup="Item"/>
<xs:complexType name="COMPONENT_TYPE">
    <xs:complexContent>
        <xs:extension base="ITEM_TYPE">
            <xs:sequence>
                <xs:element ref="Component" minOccurs="0" maxOccurs="unbounded"/>
            </xs:sequence>
            <xs:attribute name="designator" type="xs:string" use="optional"/>
            <xs:attribute name="imageId" type="xs:string" use="optional"/>
            <xs:attribute name="recognitionReference" type="xs:string" use="optional"/>
        </xs:extension>
    </xs:complexContent>
</xs:complexType>
```

Graphical Representation:

Schema (cont.):

```
<!--IPC2546FA: Nested Elements-->
<xs:element name="EndEffector">
    <xs:complexType>
        <xs:attribute name="endEffectorType" type="xs:string" use="required"/>
        <xs:attribute name="endEffectorBaseId" type="xs:string" use="required"/>
        <xs:attribute name="endEffectorToolId" type="xs:string" use="optional"/>
        <xs:attribute name="endEffectorSegmentId" type="xs:string" use="optional"/>
    </xs:complexType>
</xs:element>
```



Graphical Representation:

Schema (cont.):

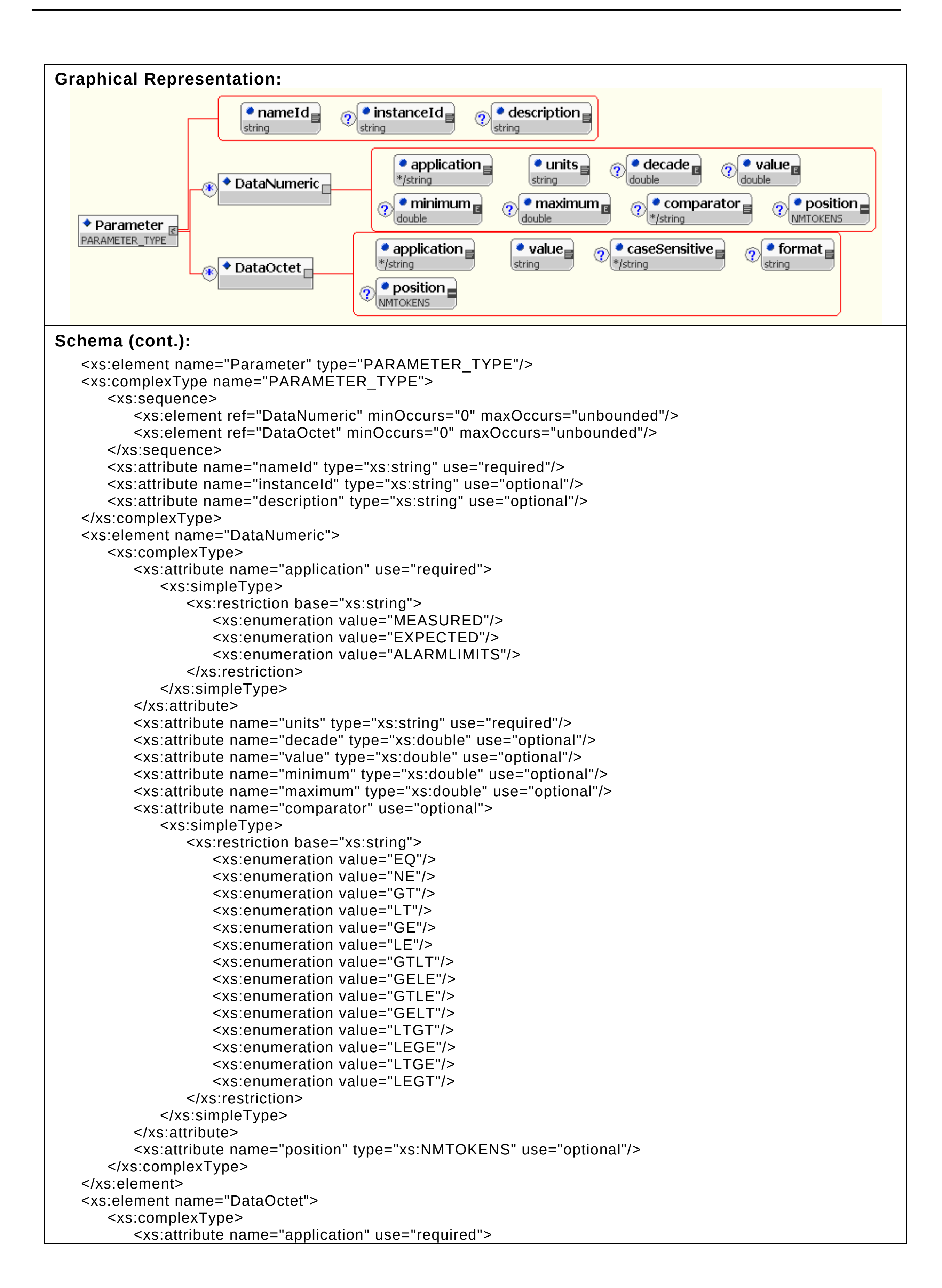
```
<xs:element name="MaterialHandler">
    <xs:complexType>
        <xs:choice>
            <xs:element name="Feeder">
                <xs:complexType>
                    <xs:attribute name="trackId" type="xs:positiveInteger" use="required"/>
                    <xs:attribute name="materialHandlerTableId" type="xs:string" use="optional"/>
                </xs:complexType>
            </xs:element>
            <xs:element name="TrayFeeder">
                <xs:complexType>
                    <xs:attribute name="trayFeederTower" type="xs:positiveInteger" use="required"/>
                    <xs:attribute name="traySection" type="xs:string" use="required"/>
                    <xs:attribute name="trayFeederLocation" type="xs:positiveInteger" use="optional"/>
                    <xs:attribute name="trayId" type="xs:string" use="optional"/>
                </xs:complexType>
            </xs:element>
        </xs:choice>
        <xs:attribute name="materialSupplyArea" type="xs:string" use="required"/>
        <xs:attribute name="feederType" type="xs:string" use="required"/>
        <xs:attribute name="feederDivision" type="xs:string" use="required"/>
        <xs:attribute name="feederId" type="xs:string" use="optional"/>
    </xs:complexType>
</xs:element>
```

Graphical Representation:

Schema (cont.):

```
<xs:element name="ComponentValidation">
    <xs:complexType>
        <xs:sequence>
            <xs:element ref="ItemIdentifier" minOccurs="0" maxOccurs="unbounded"/>
        </xs:sequence>
        <xs:attribute name="itemType" type="xs:string" use="required"/>
        <xs:attribute name="vendorId" type="xs:string" use="optional"/>
    </xs:complexType>
</xs:element>
```

Graphical Representation:



Schema (cont.):

```
<xs:element name="Parameter" type="PARAMETER_TYPE"/>
<xs:complexType name="PARAMETER_TYPE">
    <xs:sequence>
        <xs:element ref="DataNumeric" minOccurs="0" maxOccurs="unbounded"/>
        <xs:element ref="DataOctet" minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:attribute name="nameId" type="xs:string" use="required"/>
    <xs:attribute name="instanceId" type="xs:string" use="optional"/>
    <xs:attribute name="description" type="xs:string" use="optional"/>
</xs:complexType>
<xs:element name="DataNumeric">
    <xs:complexType>
        <xs:attribute name="application" use="required">
            <xs:simpleType>
                <xs:restriction base="xs:string">
                    <xs:enumeration value="MEASURED"/>
                    <xs:enumeration value="EXPECTED"/>
                    <xs:enumeration value="ALARMLIMITS"/>
                </xs:restriction>
            </xs:simpleType>
        </xs:attribute>
        <xs:attribute name="units" type="xs:string" use="required"/>
        <xs:attribute name="decade" type="xs:double" use="optional"/>
        <xs:attribute name="value" type="xs:double" use="optional"/>
        <xs:attribute name="minimum" type="xs:double" use="optional"/>
        <xs:attribute name="maximum" type="xs:double" use="optional"/>
        <xs:attribute name="comparator" use="optional">
            <xs:simpleType>
                <xs:restriction base="xs:string">
                    <xs:enumeration value="EQ"/>
                    <xs:enumeration value="NE"/>
                    <xs:enumeration value="GT"/>
                    <xs:enumeration value="LT"/>
                    <xs:enumeration value="GE"/>
                    <xs:enumeration value="LE"/>
                    <xs:enumeration value="GTLT"/>
                    <xs:enumeration value="GELE"/>
                    <xs:enumeration value="GTLE"/>
                    <xs:enumeration value="GELT"/>
                    <xs:enumeration value="LTGT"/>
                    <xs:enumeration value="LEGE"/>
                    <xs:enumeration value="LTGE"/>
                    <xs:enumeration value="LEGT"/>
                </xs:restriction>
            </xs:simpleType>
        </xs:attribute>
        <xs:attribute name="position" type="xs:NMTOKENS" use="optional"/>
    </xs:complexType>
</xs:element>
<xs:element name="DataOctet">
    <xs:complexType>
        <xs:attribute name="application" use="required">
```

```
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:enumeration value="MEASURED"/>
                        <xs:enumeration value="EXPECTED"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:attribute>
            <xs:attribute name="value" type="xs:string" use="required"/>
            <xs:attribute name="caseSensitive" use="optional">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:enumeration value="YES"/>
                        <xs:enumeration value="NO"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:attribute>
            <xs:attribute name="format" type="xs:string" use="optional"/>
            <xs:attribute name="position" type="xs:NMTOKENS" use="optional"/>
        </xs:complexType>
    </xs:element>
```

Graphical Representation:

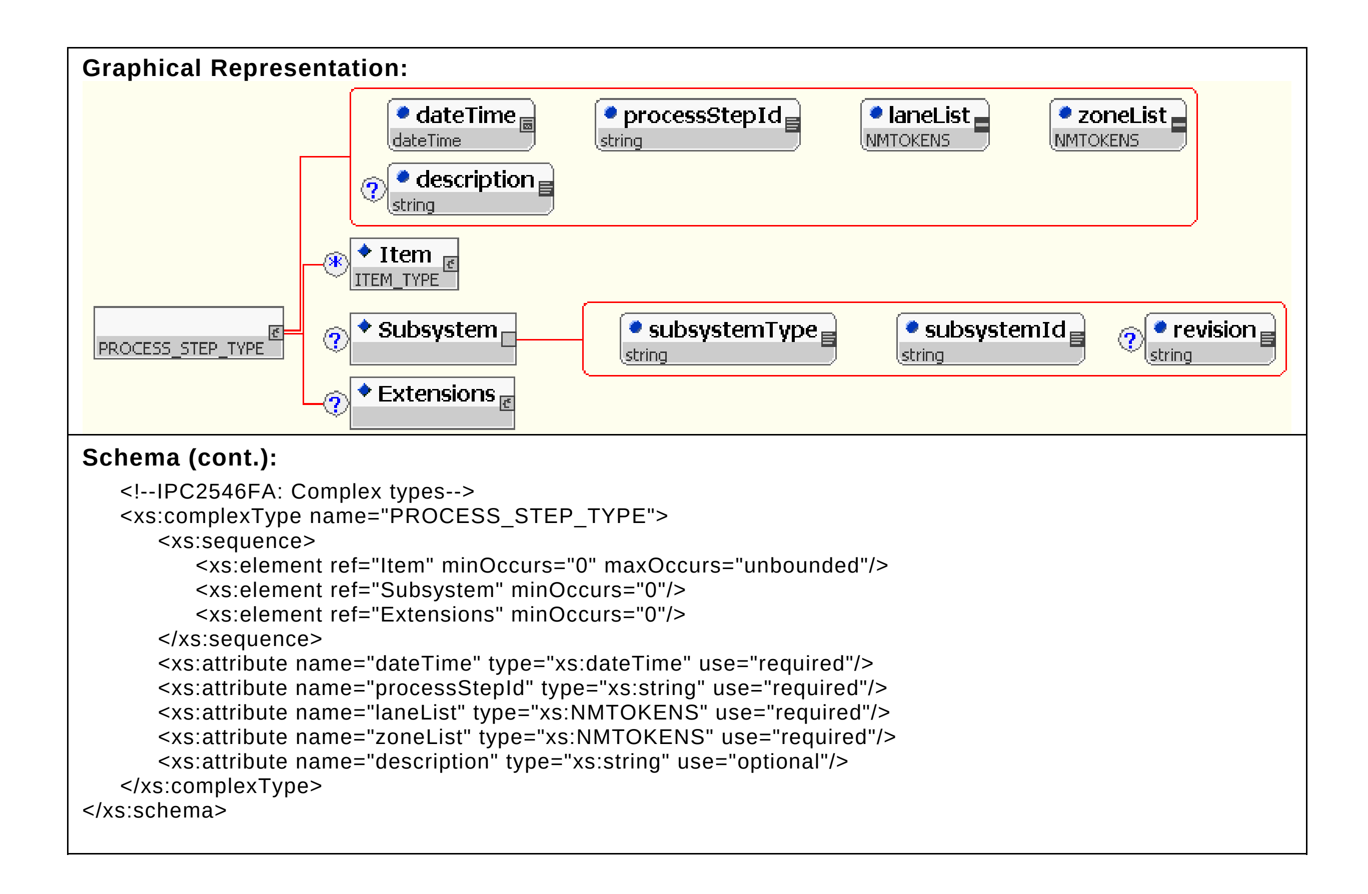
Schema (cont.):

```
<xs:element name="Recipe">
    <xs:complexType>
        <xs:attribute name="recipeId" type="xs:string" use="required"/>
        <xs:attribute name="revision" type="xs:string" use="optional"/>
        <xs:attribute name="laneList" type="xs:NMTOKENS" use="optional"/>
        <xs:attribute name="zoneList" type="xs:NMTOKENS" use="optional"/>
        <xs:attribute name="recipeStep" type="xs:string" use="optional"/>
        <xs:attribute name="command" type="xs:string" use="optional"/>
        <xs:attribute name="description" type="xs:string" use="optional"/>
    </xs:complexType>
</xs:element>
```

Schema (cont.):

```
<!--IPC2546FA: Simple Types-->
<xs:simpleType name="INITIATOR_STYPE">
    <xs:restriction base="xs:string">
        <xs:enumeration value="OPERATOR"/>
        <xs:enumeration value="AUTOMATIC"/>
    </xs:restriction>
</xs:simpleType>
```

Graphical Representation:



Schema (cont.):

```
    <!--IPC2546FA: Complex types-->
    <xs:complexType name="PROCESS_STEP_TYPE">
        <xs:sequence>
            <xs:element ref="Item" minOccurs="0" maxOccurs="unbounded"/>
            <xs:element ref="Subsystem" minOccurs="0"/>
            <xs:element ref="Extensions" minOccurs="0"/>
        </xs:sequence>
        <xs:attribute name="dateTime" type="xs:dateTime" use="required"/>
        <xs:attribute name="processStepId" type="xs:string" use="required"/>
        <xs:attribute name="laneList" type="xs:NMTOKENS" use="required"/>
        <xs:attribute name="zoneList" type="xs:NMTOKENS" use="required"/>
        <xs:attribute name="description" type="xs:string" use="optional"/>
    </xs:complexType>
</xs:schema>
```

Extension Messages:

8.9.2 EquipmentSubsystemCaution

URL: http://webstds.ipc.org/2546/fa/EquipmentSubsystemCaution.xsd

Extends:
http://webstds.ipc.org/2541/EquipmentAlarm.xsd,
http://webstds.ipc.org/2541/EquipmentError.xsd,
http://webstds.ipc.org/2541/EquipmentWarning.xsd

Includes: http://webstds.ipc.org/2546/Component_lib_IPC-2546.xsd

Graphical Representation:

Schema:

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified"
attributeFormDefault="unqualified">
    <xs:include schemaLocation="../Component_lib_IPC-2546.xsd"/>
    <xs:element name="EquipmentSubsystemCaution">
        <xs:complexType>
            <xs:sequence>
                <xs:element ref="MachineError"/>
                <xs:element ref="Extensions" minOccurs="0"/>
            </xs:sequence>
        </xs:complexType>
    </xs:element>
<!--
    <xs:element name="MachineError">
        <xs:complexType>
            <xs:sequence>
                <xs:element ref="Subsystem"/>
            </xs:sequence>
            <xs:attribute name="vendorErrorCode" type="xs:string" use="optional"/>
            <xs:attribute name="description" type="xs:string" use="optional"/>
        </xs:complexType>
    </xs:element>
    <xs:element name="Subsystem">
        <xs:complexType>
            <xs:attribute name="subsystemType" type="xs:string" use="required"/>
            <xs:attribute name="subsystemId" type="xs:string" use="required"/>
            <xs:attribute name="revision" type="xs:string" use="optional"/>
        </xs:complexType>
    </xs:element>
-->
</xs:schema>
```

8.9.3 ProcessParameterCaution

URL: http://webstds.ipc.org/2546/fa/ProcessParameterCaution.xsd

Extends:
http://webstds.ipc.org/2541/EquipmentAlarm.xsd,
http://webstds.ipc.org/2541/EquipmentError.xsd,
http://webstds.ipc.org/2541/EquipmentWarning.xsd

Includes: http://webstds.ipc.org/2546/fa/Component_lib_IPC-2546_FA.xsd

Graphical Representation:

ProcessParameterCaution
nameId string
instanceId string
description string
DataNumeric
2..*
application */string
units string
decade double
value double
minimum double
maximum double
comparator */string
position NMTOKENS
Extensions

Schema:

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified"
attributeFormDefault="unqualified">
    <xs:include schemaLocation="./Component_lib_IPC-2546_FA.xsd"/>
    <xs:element name="ProcessParameterCaution">
        <xs:complexType>
            <xs:sequence>
                <xs:element ref="DataNumeric" minOccurs="2" maxOccurs="unbounded"/>
                <xs:element ref="Extensions" minOccurs="0"/>
            </xs:sequence>
            <xs:attribute name="nameId" type="xs:string" use="required"/>
            <xs:attribute name="instanceId" type="xs:string" use="optional"/>
            <xs:attribute name="description" type="xs:string" use="optional"/>
        </xs:complexType>
    </xs:element>
</xs:schema>
```

8.9.4 EquipmentOutOfItem

URL: http://webstds.ipc.org/2546/fa/EquipmentOutOfItem.xsd

Extends:
http://webstds.ipc.org/2541/EquipmentAlarm.xsd,
http://webstds.ipc.org/2541/EquipmentError.xsd,
http://webstds.ipc.org/2541/EquipmentWarning.xsd

Includes: http://webstds.ipc.org/2546/fa/Component_lib_IPC-2546_FA.xsd

Graphical Representation:

Schema:

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified"
attributeFormDefault="unqualified">
    <xs:include schemaLocation="./Component_lib_IPC-2546_FA.xsd"/>
    <xs:element name="EquipmentOutOfItem">
        <xs:complexType>
            <xs:sequence>
                <xs:element ref="Item"/>
                <xs:element ref="Extensions" minOccurs="0"/>
            </xs:sequence>
            <xs:attribute name="description" type="xs:string"/>
        </xs:complexType>
    </xs:element>
</xs:schema>
```

8.9.5 ItemMissPick

URL: http://webstds.ipc.org/2546/fa/ItemMissPick.xsd

Extends:
http://webstds.ipc.org/2541/EquipmentAlarm.xsd,
http://webstds.ipc.org/2541/EquipmentError.xsd,
http://webstds.ipc.org/2541/EquipmentWarning.xsd

Includes: http://webstds.ipc.org/2546/fa/Component_lib_IPC-2546_FA.xsd

Graphical Representation:

ItemMissPick
cautionType */string
description string
EndEffector
endEffectorType string
endEffectorBaseId string
endEffectorToolId string
endEffectorSegmentId string
MaterialHandler
materialSupplyArea string
feederType string
feederDivision string
feederId string
Feeder
trackId positiveInteger
materialHandlerTableId string
TrayFeeder
trayFeederTower positiveInteger
traySection string
trayFeederLocation positiveInteger
trayId string
Item ITEM_TYPE
Recipe
recipeId string
revision string
laneList NMTOKENS
zoneList NMTOKENS
recipeStep string
command string
description string
Extensions

Schema:

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified"
attributeFormDefault="unqualified">
    <xs:include schemaLocation="./Component_lib_IPC-2546_FA.xsd"/>
    <xs:element name="ItemMissPick">
        <xs:complexType>
            <xs:sequence>
                <xs:element ref="EndEffector"/>
                <xs:element ref="MaterialHandler"/>
                <xs:element ref="Item"/>
                <xs:element ref="Recipe" minOccurs="0"/>
                <xs:element ref="Extensions" minOccurs="0"/>
            </xs:sequence>
            <xs:attribute name="cautionType" use="required">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:enumeration value="MISSINGITEM"/>
                        <xs:enumeration value="MISALIGNEDITEM"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:attribute>
            <xs:attribute name="description" type="xs:string" use="optional"/>
        </xs:complexType>
    </xs:element>
</xs:schema>
```

8.9.6 ItemRecognitionFailureFa

URL: http://webstds.ipc.org/2546/fa/ItemRecognitionFailureFa.xsd

Extends:
http://webstds.ipc.org/2541/EquipmentAlarm.xsd
http://webstds.ipc.org/2541/EquipmentError.xsd
http://webstds.ipc.org/2541/EquipmentWarning.xsd

Includes:
http://webstds.ipc.org/2546/fa/Component_lib_IPC-2546_FA.xsd

Graphical Representation:

Schema:

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified"
attributeFormDefault="unqualified">
    <xs:include schemaLocation="./Component_lib_IPC-2546_FA.xsd"/>
    <xs:element name="ItemRecognitionFailureFa">
        <xs:complexType>
            <xs:sequence>
                <xs:element ref="Item" minOccurs="0"/>
                <xs:element ref="Fiducial" minOccurs="0"/>
                <xs:element ref="Subsystem" minOccurs="0"/>
                <xs:element ref="Recipe" minOccurs="0"/>
                <xs:element ref="Extensions" minOccurs="0"/>
            </xs:sequence>
            <xs:attribute name="cautionType" use="required">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:enumeration value="BADMEASUREMENT"/>
                        <xs:enumeration value="READERROR"/>
                        <xs:enumeration value="IDENTIFIERNOTFOUND"/>
                        <xs:enumeration value="IDENTIFIERMISMATCH"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:attribute>
            <xs:attribute name="itemType" use="optional">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:enumeration value="CONTAINER"/>
                        <xs:enumeration value="COMPONENT"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:attribute>
            <xs:attribute name="description" type="xs:string" use="optional"/>
        </xs:complexType>
    </xs:element>
<!--
    <xs:element name="Fiducial">
        <xs:complexType>
```

```
            <xs:attribute name="designator" type="xs:string" use="required"/>
            <xs:attribute name="imageId" type="xs:string" use="optional"/>
            <xs:attribute name="imageType" use="optional">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:enumeration value="LOCAL"/>
                        <xs:enumeration value="GLOBAL"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:attribute>
            <xs:attribute name="imageShape" type="xs:string" use="optional"/>
            <xs:attribute name="recognitionReference" type="xs:string" use="optional"/>
            <xs:attribute name="score" type="xs:positiveInteger" use="optional"/>
        </xs:complexType>
    </xs:element>
    <xs:element name="Subsystem">
        <xs:complexType>
            <xs:attribute name="subsystemType" type="xs:string" use="required"/>
            <xs:attribute name="subsystemId" type="xs:string" use="required"/>
            <xs:attribute name="revision" type="xs:string" use="optional"/>
        </xs:complexType>
    </xs:element>
-->
</xs:schema>
```

8.9.7 ItemDidNotTransferSuccessfullyFa

URL: http://webstds.ipc.org/2546/fa/ItemDidNotTransferSuccessfullyFa.xsd

Extends:

http://webstds.ipc.org/2541/EquipmentAlarm.xsd,
http://webstds.ipc.org/2541/EquipmentError.xsd,
http://webstds.ipc.org/2541/EquipmentWarning.xsd

Includes: http://webstds.ipc.org/2546/fa/Component_lib_IPC-2546_FA.xsd

Graphical Representation:

Schema:

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified"
attributeFormDefault="unqualified">
    <xs:include schemaLocation="./Component_lib_IPC-2546_FA.xsd"/>
    <xs:element name="ItemDidNotTransferSuccessfullyFa">
        <xs:complexType>
            <xs:sequence>
                <xs:element ref="Item" minOccurs="0"/>
                <xs:element ref="Recipe" minOccurs="0"/>
                <xs:element ref="Extensions" minOccurs="0"/>
            </xs:sequence>
            <xs:attribute name="cautionType" use="required">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:enumeration value="TIMEOUT"/>
                        <xs:enumeration value="JAM"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:attribute>
            <xs:attribute name="itemType" use="required">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:enumeration value="CONTAINER"/>
                        <xs:enumeration value="COMPONENT"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:attribute>
            <xs:attribute name="description" type="xs:string" use="optional"/>
        </xs:complexType>
    </xs:element>
</xs:schema>
```

8.9.8 MaterialHandlerLowFa

URL: http://webstds.ipc.org/2546/fa/MaterialHandlerLowFa.xsd

Extends:

http://webstds.ipc.org/2541/EquipmentAlarm.xsd
http://webstds.ipc.org/2541/EquipmentError.xsd
http://webstds.ipc.org/2541/EquipmentWarning.xsd

Includes: http://webstds.ipc.org/2546/fa/Component_lib_IPC-2546_FA.xsd

Graphical Representation:

Schema:

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified"
attributeFormDefault="unqualified">
    <xs:include schemaLocation="./Component_lib_IPC-2546_FA.xsd"/>
    <xs:element name="MaterialHandlerLowFa">
        <xs:complexType>
            <xs:sequence>
                <xs:element ref="MaterialHandler"/>
                <xs:element ref="Item" minOccurs="0"/>
                <xs:element ref="Extensions" minOccurs="0"/>
            </xs:sequence>
            <xs:attribute name="cautionType" use="required">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:enumeration value="MEASUREDMATERIALHANDLERLOW"/>
                        <xs:enumeration value="ESTIMATEDMATERIALHANDLERLOW"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:attribute>
            <xs:attribute name="estimatedTimeTillEndOfComponents" type="xs:duration" use="optional"/>
            <xs:attribute name="description" type="xs:string" use="optional"/>
            <xs:attribute name="numberOfComponentsLeft" type="xs:nonNegativeInteger" use="optional"/>
        </xs:complexType>
    </xs:element>
</xs:schema>
```

8.9.9 MaterialHandlerProblemFa

URL: http://webstds.ipc.org/2546/fa/MaterialHandlerProblemFa.xsd

Extends:

http://webstds.ipc.org/2541/EquipmentAlarm.xsd
http://webstds.ipc.org/2541/EquipmentError.xsd
http://webstds.ipc.org/2541/EquipmentWarning.xsd

Includes: http://webstds.ipc.org/2546/fa/Component_lib_IPC-2546_FA.xsd

Graphical Representation:

Schema:

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified"
attributeFormDefault="unqualified">
    <xs:include schemaLocation="./Component_lib_IPC-2546_FA.xsd"/>
    <xs:element name="MaterialHandlerProblemFa">
        <xs:complexType>
            <xs:sequence>
                <xs:element ref="MaterialHandler"/>
                <xs:element ref="Item" minOccurs="0"/>
                <xs:element ref="Extensions" minOccurs="0"/>
            </xs:sequence>
            <xs:attribute name="description" type="xs:string" use="optional"/>
        </xs:complexType>
    </xs:element>
</xs:schema>
```

8.9.10 MaterialHandlerOutOfItemsFa

URL: http://webstds.ipc.org/2546/fa/MaterialHandlerOutOfItemsFa.xsd

Extends:

http://webstds.ipc.org/2541/EquipmentAlarm.xsd
http://webstds.ipc.org/2541/EquipmentError.xsd
http://webstds.ipc.org/2541/EquipmentWarning.xsd

Includes: http://webstds.ipc.org/2546/fa/Component_lib_IPC-2546_FA.xsd

Graphical Representation:

Schema:

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified"
attributeFormDefault="unqualified">
    <xs:include schemaLocation="./Component_lib_IPC-2546_FA.xsd"/>
    <xs:element name="MaterialHandlerOutOfItemsFa">
        <xs:complexType>
            <xs:sequence>
                <xs:element ref="MaterialHandler"/>
                <xs:element ref="Item"/>
                <xs:element ref="Extensions" minOccurs="0"/>
            </xs:sequence>
            <xs:attribute name="decrementMispickCount" type="xs:positiveInteger" use="optional"/>
            <xs:attribute name="description" type="xs:string" use="optional"/>
        </xs:complexType>
    </xs:element>
</xs:schema>
```

8.9.11 ItemPlacementFailure

URL: http://webstds.ipc.org/2546/fa/ItemPlacementFailure.xsd

Extends:

http://webstds.ipc.org/2541/EquipmentAlarm.xsd
http://webstds.ipc.org/2541/EquipmentError.xsd
http://webstds.ipc.org/2541/EquipmentWarning.xsd

Includes: http://webstds.ipc.org/2546/fa/Component_lib_IPC-2546_FA.xsd

Graphical Representation:

ItemPlacementFailure
cautionType */string
description string
recipeStep string
targetDesignator string
EndEffector
endEffectorType string
endEffectorBaseId string
endEffectorToolId string
endEffectorSegmentId string
Item ITEM_TYPE
MaterialHandler
materialSupplyArea string
feederType string
feederDivision string
feederId string
Feeder
trackId positiveInteger
materialHandlerTableId string
TrayFeeder
trayFeederTower positiveInteger
traySection string
trayFeederLocation positiveInteger
trayId string
Recipe
recipeId string
revision string
laneList NMTOKENS
zoneList NMTOKENS
recipeStep string
command string
description string
TargetItem
Item ITEM_TYPE
Extensions

Schema:

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified"
attributeFormDefault="unqualified">
    <xs:include schemaLocation="./Component_lib_IPC-2546_FA.xsd"/>
    <xs:element name="ItemPlacementFailure">
        <xs:complexType>
            <xs:sequence>
                <xs:element ref="EndEffector"/>
                <xs:element ref="Item"/>
                <xs:element ref="MaterialHandler" minOccurs="0"/>
                <xs:element ref="Recipe" minOccurs="0"/>
                <xs:element name="TargetItem" minOccurs="0">
                    <xs:complexType>
                        <xs:sequence>
                            <xs:element ref="Item"/>
                        </xs:sequence>
                    </xs:complexType>
                </xs:element>
                <xs:element ref="Extensions" minOccurs="0"/>
            </xs:sequence>
            <xs:attribute name="cautionType" use="required">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:enumeration value="LOSTDURINGMOVEMENT"/>
                        <xs:enumeration value="LOST"/>
                        <xs:enumeration value="MISPLACED"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:attribute>
            <xs:attribute name="description" type="xs:string" use="optional"/>
            <xs:attribute name="recipeStep" type="xs:string" use="optional"/>
            <xs:attribute name="targetDesignator" type="xs:string" use="optional"/>
        </xs:complexType>
    </xs:element>
</xs:schema>
```

8.9.12 ItemFailure

URL: http://webstds.ipc.org/2546/fa/ItemFailure.xsd

Extends:
http://webstds.ipc.org/2541/EquipmentAlarm.xsd
http://webstds.ipc.org/2541/EquipmentError.xsd
http://webstds.ipc.org/2541/EquipmentWarning.xsd

Includes: http://webstds.ipc.org/2546/fa/Component_lib_IPC-2546_FA.xsd

Graphical Representation:

Schema:

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified"
attributeFormDefault="unqualified">
    <xs:include schemaLocation="./Component_lib_IPC-2546_FA.xsd"/>
    <xs:element name="ItemFailure">
        <xs:complexType>
            <xs:sequence>
                <xs:element ref="Item"/>
                <xs:element ref="EndEffector" minOccurs="0"/>
                <xs:element ref="MaterialHandler" minOccurs="0"/>
                <xs:element ref="Recipe" minOccurs="0"/>
                <xs:element ref="Extensions" minOccurs="0"/>
            </xs:sequence>
            <xs:attribute name="cautionType" use="required">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:enumeration value="OUTOFSPECIFICATION"/>
                        <xs:enumeration value="OUTOFTOLERANCE"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:attribute>
            <xs:attribute name="description" type="xs:string" use="optional"/>
        </xs:complexType>
    </xs:element>
</xs:schema>
```

8.9.13 ItemReject

URL: http://webstds.ipc.org/2546/fa/ItemReject.xsd

Extends: http://webstds.ipc.org/2541/EquipmentInformation.xsd

Includes: http://webstds.ipc.org/2546/fa/Component_lib_IPC-2546_FA.xsd

Graphical Representation:

Schema:

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified"
attributeFormDefault="unqualified">
    <xs:include schemaLocation="./Component_lib_IPC-2546_FA.xsd"/>
    <xs:element name="ItemReject">
        <xs:complexType>
            <xs:sequence>
                <xs:element ref="Item" minOccurs="0"/>
                <xs:element ref="Extensions" minOccurs="0"/>
            </xs:sequence>
            <xs:attribute name="rejectLocation" type="xs:string" use="required"/>
            <xs:attribute name="description" type="xs:string" use="optional"/>
        </xs:complexType>
    </xs:element>
</xs:schema>
```

8.9.14 ProcessDataReportFa

URL: http://webstds.ipc.org/2546/fa/ProcessDataReportFa.xsd

Extends: http://webstds.ipc.org/2541/EquipmentInformation.xsd

Includes: http://webstds.ipc.org/2546/fa/Component_lib_IPC-2546_FA.xsd

Graphical Representation:

Schema:

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified"
attributeFormDefault="unqualified">
    <xs:include schemaLocation="./Component_lib_IPC-2546_FA.xsd"/>
    <xs:element name="ProcessDataReportFa">
        <xs:complexType>
            <xs:sequence>
                <xs:element ref="Parameter" maxOccurs="unbounded"/>
                <xs:element ref="Item" minOccurs="0" maxOccurs="unbounded"/>
                <xs:element ref="Extensions" minOccurs="0"/>
            </xs:sequence>
            <xs:attribute name="nameId" type="xs:string" use="required"/>
            <xs:attribute name="description" type="xs:string" use="optional"/>
        </xs:complexType>
    </xs:element>
</xs:schema>
```

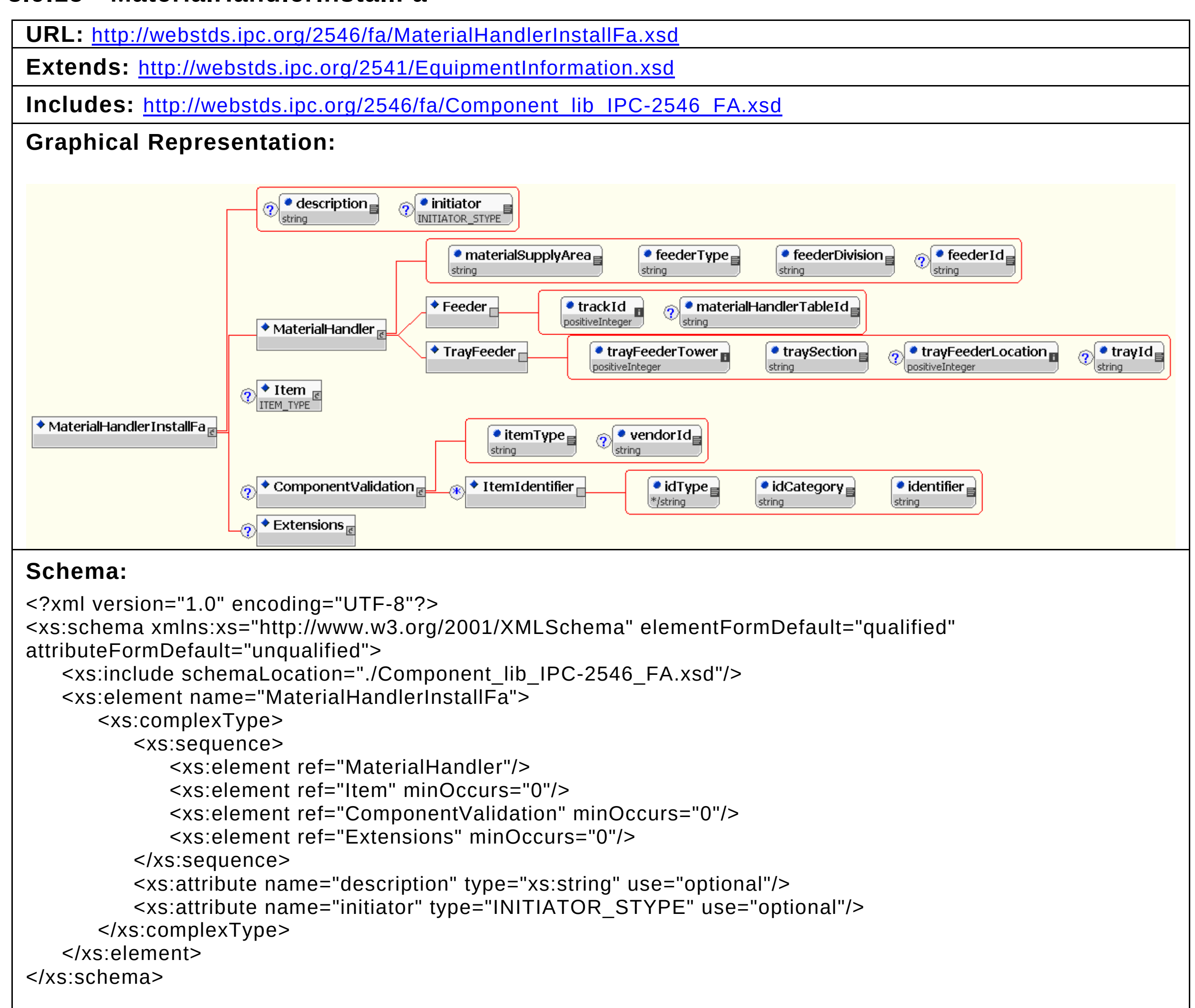
8.9.15 MaterialHandlerInstallFa

URL: http://webstds.ipc.org/2546/fa/MaterialHandlerInstallFa.xsd

Extends: http://webstds.ipc.org/2541/EquipmentInformation.xsd

Includes: http://webstds.ipc.org/2546/fa/Component_lib_IPC-2546_FA.xsd

Graphical Representation:



Schema:

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified"
attributeFormDefault="unqualified">
    <xs:include schemaLocation="./Component_lib_IPC-2546_FA.xsd"/>
    <xs:element name="MaterialHandlerInstallFa">
        <xs:complexType>
            <xs:sequence>
                <xs:element ref="MaterialHandler"/>
                <xs:element ref="Item" minOccurs="0"/>
                <xs:element ref="ComponentValidation" minOccurs="0"/>
                <xs:element ref="Extensions" minOccurs="0"/>
            </xs:sequence>
            <xs:attribute name="description" type="xs:string" use="optional"/>
            <xs:attribute name="initiator" type="INITIATOR_STYPE" use="optional"/>
        </xs:complexType>
    </xs:element>
</xs:schema>
```

8.9.16 MaterialHandlerUnInstallFa

URL: http://webstds.ipc.org/2546/fa/MaterialHandlerUnInstallFa.xsd

Extends: http://webstds.ipc.org/2541/EquipmentInformation.xsd

Includes: http://webstds.ipc.org/2546/fa/Component_lib_IPC-2546_FA.xsd

Graphical Representation:

Schema:

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified"
attributeFormDefault="unqualified">
    <xs:include schemaLocation="./Component_lib_IPC-2546_FA.xsd"/>
    <xs:element name="MaterialHandlerUnInstallFa">
        <xs:complexType>
            <xs:sequence>
                <xs:element ref="MaterialHandler"/>
                <xs:element ref="Item" minOccurs="0"/>
                <xs:element ref="Extensions" minOccurs="0"/>
            </xs:sequence>
            <xs:attribute name="description" type="xs:string" use="optional"/>
            <xs:attribute name="initiator" type="INITIATOR_STYPE" use="optional"/>
        </xs:complexType>
    </xs:element>
</xs:schema>
```

8.9.17 MaterialHandlerAmountChangeFa

URL: http://webstds.ipc.org/2546/fa/MaterialHandlerAmountChangeFa.xsd

Extends: http://webstds.ipc.org/2541/EquipmentInformation.xsd

Includes: http://webstds.ipc.org/2546/fa/Component_lib_IPC-2546_FA.xsd

Graphical Representation:

Schema:

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified"
attributeFormDefault="unqualified">
    <xs:include schemaLocation="./Component_lib_IPC-2546_FA.xsd"/>
    <xs:element name="MaterialHandlerAmountChangeFa">
        <xs:complexType>
            <xs:sequence>
                <xs:element ref="MaterialHandler"/>
                <xs:element name="Amount" minOccurs="0">
                    <xs:complexType>
                        <xs:attribute name="amount" type="xs:integer" use="required"/>
                        <xs:attribute name="changeType" use="required">
                            <xs:simpleType>
                                <xs:restriction base="xs:string">
                                    <xs:enumeration value="ABSOLUTE"/>
                                    <xs:enumeration value="DIFFERENTIAL"/>
                                </xs:restriction>
                            </xs:simpleType>
                        </xs:attribute>
                    </xs:complexType>
                </xs:element>
                <xs:element ref="ComponentValidation" minOccurs="0"/>
                <xs:element ref="Item" minOccurs="0"/>
                <xs:element ref="Extensions" minOccurs="0"/>
            </xs:sequence>
            <xs:attribute name="description" type="xs:string" use="optional"/>
            <xs:attribute name="initiator" type="INITIATOR_STYPE" use="optional"/>
        </xs:complexType>
    </xs:element>
</xs:schema>
```

8.9.18 ParameterChangeFa

URL: http://webstds.ipc.org/2546/fa/ParameterChangeFa.xsd

Extends: http://webstds.ipc.org/2541/EquipmentParameterModified.xsd

Includes: http://webstds.ipc.org/2546/fa/Component_lib_IPC-2546_FA.xsd

Graphical Representation:

Schema:

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified"
attributeFormDefault="unqualified">
    <xs:include schemaLocation="./Component_lib_IPC-2546_FA.xsd"/>
    <xs:element name="ParameterChangeFa">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="ToParameter" type="PARAMETER_TYPE"/>
                <xs:element name="FromParameter" type="PARAMETER_TYPE" minOccurs="0"/>
                <xs:element ref="Extensions" minOccurs="0"/>
            </xs:sequence>
            <xs:attribute name="description" type="xs:string" use="optional"/>
            <xs:attribute name="initiator" type="INITIATOR_STYPE" use="optional"/>
        </xs:complexType>
    </xs:element>
</xs:schema>
```

8.9.19 TargetItem

URL: http://webstds.ipc.org/2546/fa/TargetItem.xsd

Extends:

http://webstds.ipc.org/2541/ItemWorkStart.xsd
http://webstds.ipc.org/2541/ItemWorkPause.xsd
http://webstds.ipc.org/2541/ItemWorkResume.xsd
http://webstds.ipc.org/2541/ItemWorkAbort.xsd
http://webstds.ipc.org/2541/ItemIdentifierRead.xsd

Includes: http://webstds.ipc.org/2546/fa/Component_lib_IPC-2546_FA.xsd

Graphical Representation:

Schema:

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified"
attributeFormDefault="unqualified">
    <xs:include schemaLocation="./Component_lib_IPC-2546_FA.xsd"/>
    <xs:element name="TargetItem">
        <xs:complexType>
            <xs:sequence>
                <xs:element ref="Item"/>
                <xs:element ref="Extensions" minOccurs="0"/>
            </xs:sequence>
        </xs:complexType>
    </xs:element>
</xs:schema>
```

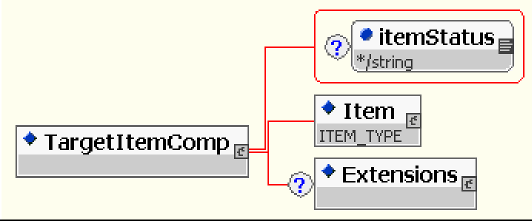
8.9.20 TargetItemComp

URL: http://webstds.ipc.org/2546/fa/TargetItemComp.xsd

Extends: http://webstds.ipc.org/2541/ItemWorkComplete.xsd

Includes: http://webstds.ipc.org/2546/fa/Component_lib_IPC-2546_FA.xsd

Graphical Representation:



Schema:

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified"
attributeFormDefault="unqualified">
    <xs:include schemaLocation="./Component_lib_IPC-2546_FA.xsd"/>
    <xs:element name="TargetItemComp">
        <xs:complexType>
            <xs:sequence>
                <xs:element ref="Item"/>
                <xs:element ref="Extensions" minOccurs="0"/>
            </xs:sequence>
            <xs:attribute name="itemStatus" use="optional">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:enumeration value="NOTPROCESSED"/>
                        <xs:enumeration value="PROCESSED"/>
                        <xs:enumeration value="OK"/>
                        <xs:enumeration value="FAILED"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:attribute>
        </xs:complexType>
    </xs:element>
</xs:schema>
```

8.9.21 EquipmentRecipeChangeFa

URL: http://webstds.ipc.org/2546/fa/EquipmentRecipeChangeFa.xsd

Extends:

http://webstds.ipc.org/2541/EquipmentSelectedRecipeModified.xsd
http://webstds.ipc.org/2541/EquipmentNonSelectedRecipeModified.xsd

Includes: http://webstds.ipc.org/2546/fa/Component_lib_IPC-2546_FA.xsd

Graphical Representation:

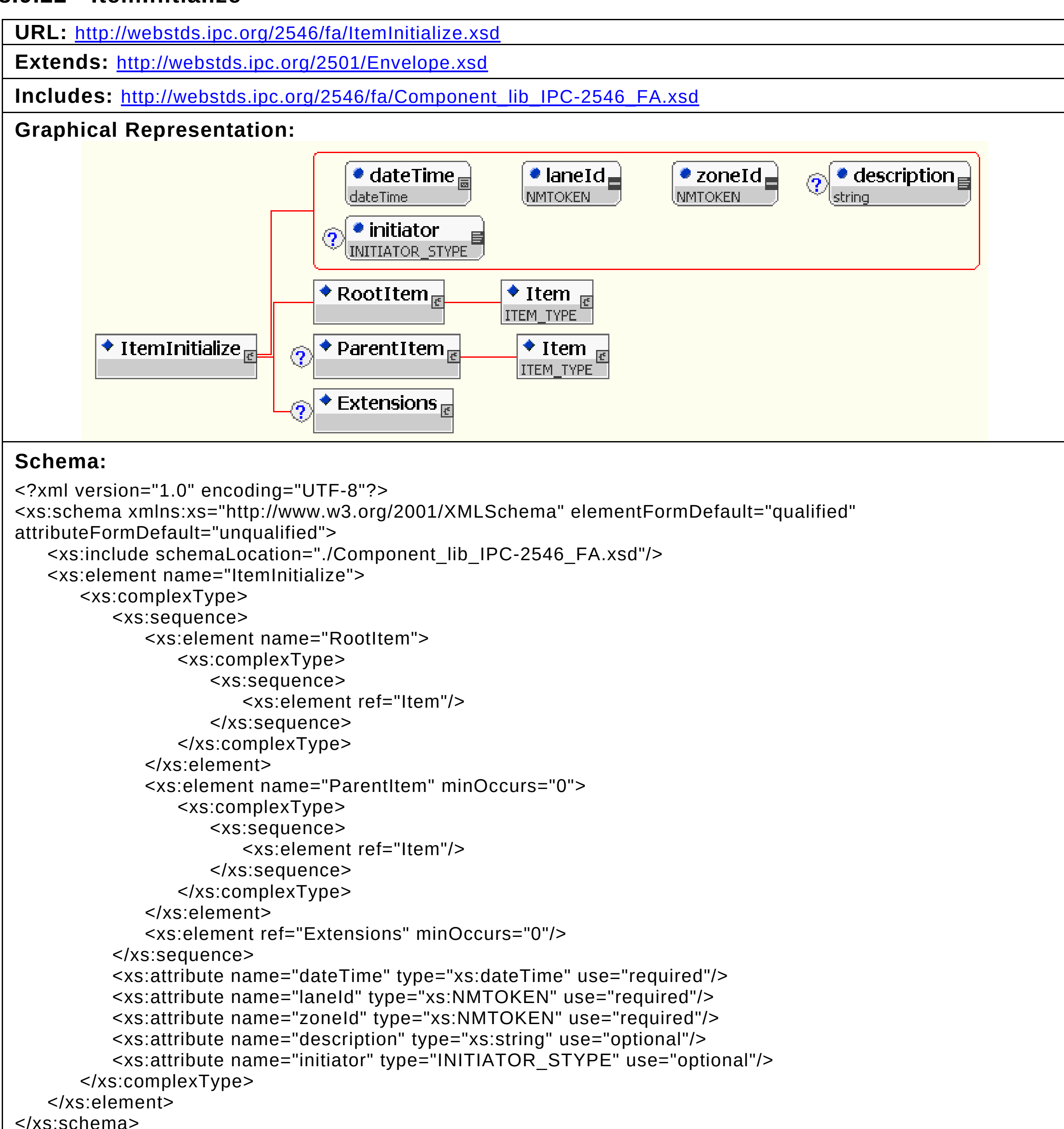
description
string
revision
string
initiatior
INITIATOR_STYPE
EquipmentRecipeChangeFa
Extensions

Schema:

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified"
attributeFormDefault="unqualified">
    <xs:include schemaLocation="./Component_lib_IPC-2546_FA.xsd"/>
    <xs:element name="EquipmentRecipeChangeFa">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="Extensions" minOccurs="0"/>
            </xs:sequence>
            <xs:attribute name="description" type="xs:string" use="optional"/>
            <xs:attribute name="revision" type="xs:string" use="optional"/>
            <xs:attribute name="initiatior" type="INITIATOR_STYPE" use="optional"/>
        </xs:complexType>
    </xs:element>
<!--
    <xs:simpleType name="INITIATOR_STYPE">
        <xs:restriction base="xs:string">
            <xs:enumeration value="OPERATOR"/>
            <xs:enumeration value="AUTOMATIC"/>
        </xs:restriction>
    </xs:simpleType>
-->
</xs:schema>
```

New Events:

8.9.22 ItemInitialize



URL: http://webstds.ipc.org/2546/fa/ItemInitialize.xsd

Extends: http://webstds.ipc.org/2501/Envelope.xsd

Includes: http://webstds.ipc.org/2546/fa/Component_lib_IPC-2546_FA.xsd

Graphical Representation:

Schema:

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified"
attributeFormDefault="unqualified">
    <xs:include schemaLocation="./Component_lib_IPC-2546_FA.xsd"/>
    <xs:element name="ItemInitialize">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="RootItem">
                    <xs:complexType>
                        <xs:sequence>
                            <xs:element ref="Item"/>
                        </xs:sequence>
                    </xs:complexType>
                </xs:element>
                <xs:element name="ParentItem" minOccurs="0">
                    <xs:complexType>
                        <xs:sequence>
                            <xs:element ref="Item"/>
                        </xs:sequence>
                    </xs:complexType>
                </xs:element>
                <xs:element ref="Extensions" minOccurs="0"/>
            </xs:sequence>
            <xs:attribute name="dateTime" type="xs:dateTime" use="required"/>
            <xs:attribute name="laneId" type="xs:NMTOKEN" use="required"/>
            <xs:attribute name="zoneId" type="xs:NMTOKEN" use="required"/>
            <xs:attribute name="description" type="xs:string" use="optional"/>
            <xs:attribute name="initiator" type="INITIATOR_STYPE" use="optional"/>
        </xs:complexType>
    </xs:element>
</xs:schema>
```

8.9.23 ItemChange

URL: http://webstds.ipc.org/2546/fa/ItemChange.xsd

Extends: http://webstds.ipc.org/2501/Envelope.xsd

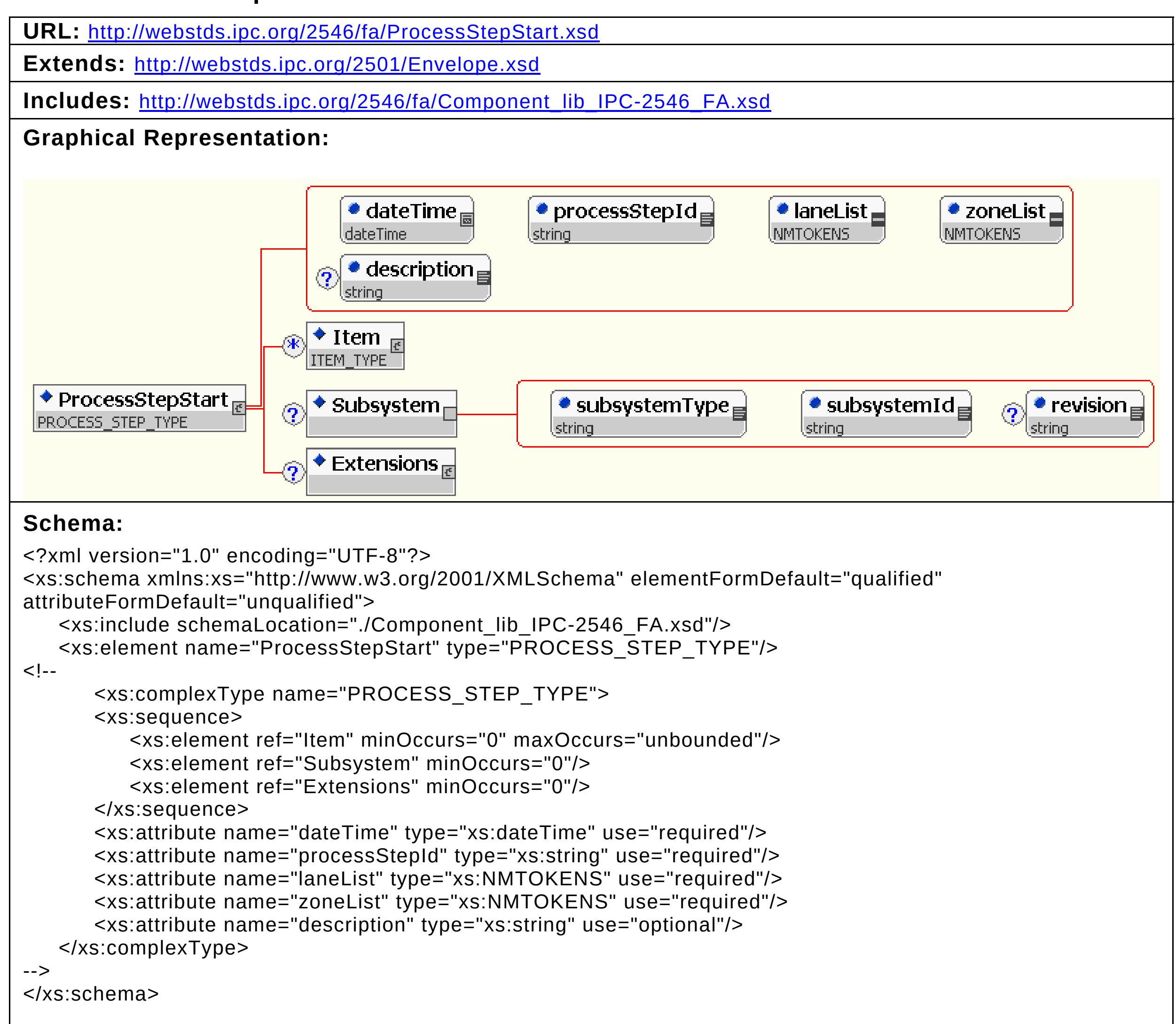
Includes: http://webstds.ipc.org/2546/fa/Component_lib_IPC-2546_FA.xsd

Graphical Representation:

Schema:

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified"
attributeFormDefault="unqualified">
    <xs:include schemaLocation="./Component_lib_IPC-2546_FA.xsd"/>
    <xs:element name="ItemChange">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="RootItem">
                    <xs:complexType>
                        <xs:sequence>
                            <xs:element ref="Item"/>
                        </xs:sequence>
                    </xs:complexType>
                </xs:element>
                <xs:element name="ParentItem">
                    <xs:complexType>
                        <xs:sequence>
                            <xs:element ref="Item"/>
                        </xs:sequence>
                    </xs:complexType>
                </xs:element>
                <xs:element name="ChildItem">
                    <xs:complexType>
                        <xs:sequence>
                            <xs:element ref="Item"/>
                        </xs:sequence>
                    </xs:complexType>
                </xs:element>
                <xs:element ref="Extensions" minOccurs="0"/>
            </xs:sequence>
            <xs:attribute name="dateTime" type="xs:dateTime" use="required"/>
            <xs:attribute name="actionType" use="required">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:enumeration value="CREATE"/>
                        <xs:enumeration value="ATTACH"/>
                        <xs:enumeration value="DETACH"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:attribute>
            <xs:attribute name="laneId" type="xs:NMTOKEN" use="required"/>
            <xs:attribute name="zoneId" type="xs:NMTOKEN" use="required"/>
            <xs:attribute name="description" type="xs:string" use="optional"/>
        </xs:complexType>
    </xs:element>
</xs:schema>
```

8.9.24 ProcessStepStart



URL: http://webstds.ipc.org/2546/fa/ProcessStepStart.xsd

Extends: http://webstds.ipc.org/2501/Envelope.xsd

Includes: http://webstds.ipc.org/2546/fa/Component_lib_IPC-2546_FA.xsd

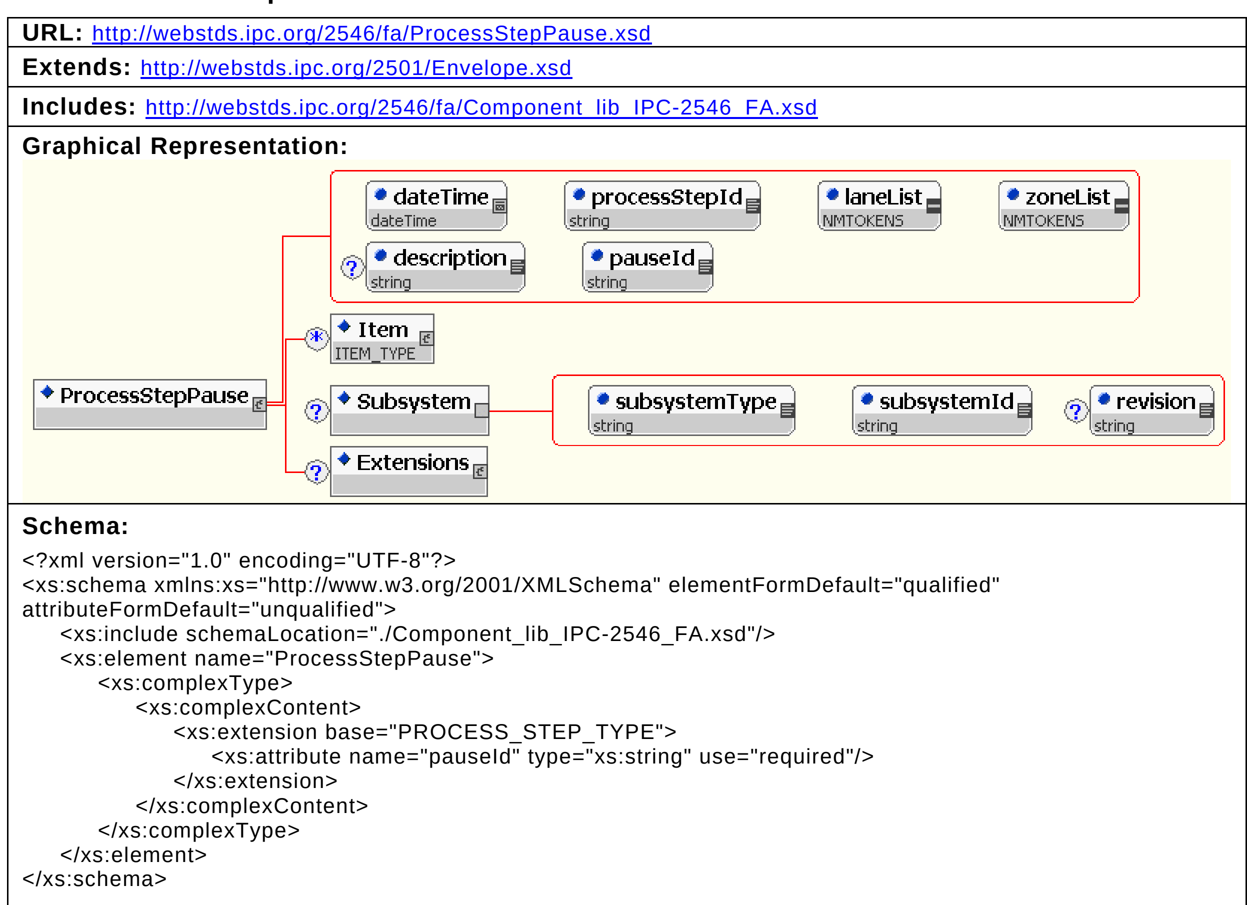
Graphical Representation:

Schema:

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified"
attributeFormDefault="unqualified">
    <xs:include schemaLocation="./Component_lib_IPC-2546_FA.xsd"/>
    <xs:element name="ProcessStepStart" type="PROCESS_STEP_TYPE"/>
<!--
        <xs:complexType name="PROCESS_STEP_TYPE">
        <xs:sequence>
            <xs:element ref="Item" minOccurs="0" maxOccurs="unbounded"/>
            <xs:element ref="Subsystem" minOccurs="0"/>
            <xs:element ref="Extensions" minOccurs="0"/>
        </xs:sequence>
        <xs:attribute name="dateTime" type="xs:dateTime" use="required"/>
        <xs:attribute name="processStepId" type="xs:string" use="required"/>
        <xs:attribute name="laneList" type="xs:NMTOKENS" use="required"/>
        <xs:attribute name="zoneList" type="xs:NMTOKENS" use="required"/>
        <xs:attribute name="description" type="xs:string" use="optional"/>
    </xs:complexType>
-->
</xs:schema>
```

8.9.25 ProcessStepPause

URL: http://webstds.ipc.org/2546/fa/ProcessStepPause.xsd
Extends: http://webstds.ipc.org/2501/Envelope.xsd
Includes: http://webstds.ipc.org/2546/fa/Component_lib_IPC-2546_FA.xsd
Graphical Representation:



Schema:

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified"
attributeFormDefault="unqualified">
    <xs:include schemaLocation="./Component_lib_IPC-2546_FA.xsd"/>
    <xs:element name="ProcessStepPause">
        <xs:complexType>
            <xs:complexContent>
                <xs:extension base="PROCESS_STEP_TYPE">
                    <xs:attribute name="pauseId" type="xs:string" use="required"/>
                </xs:extension>
            </xs:complexContent>
        </xs:complexType>
    </xs:element>
</xs:schema>
```

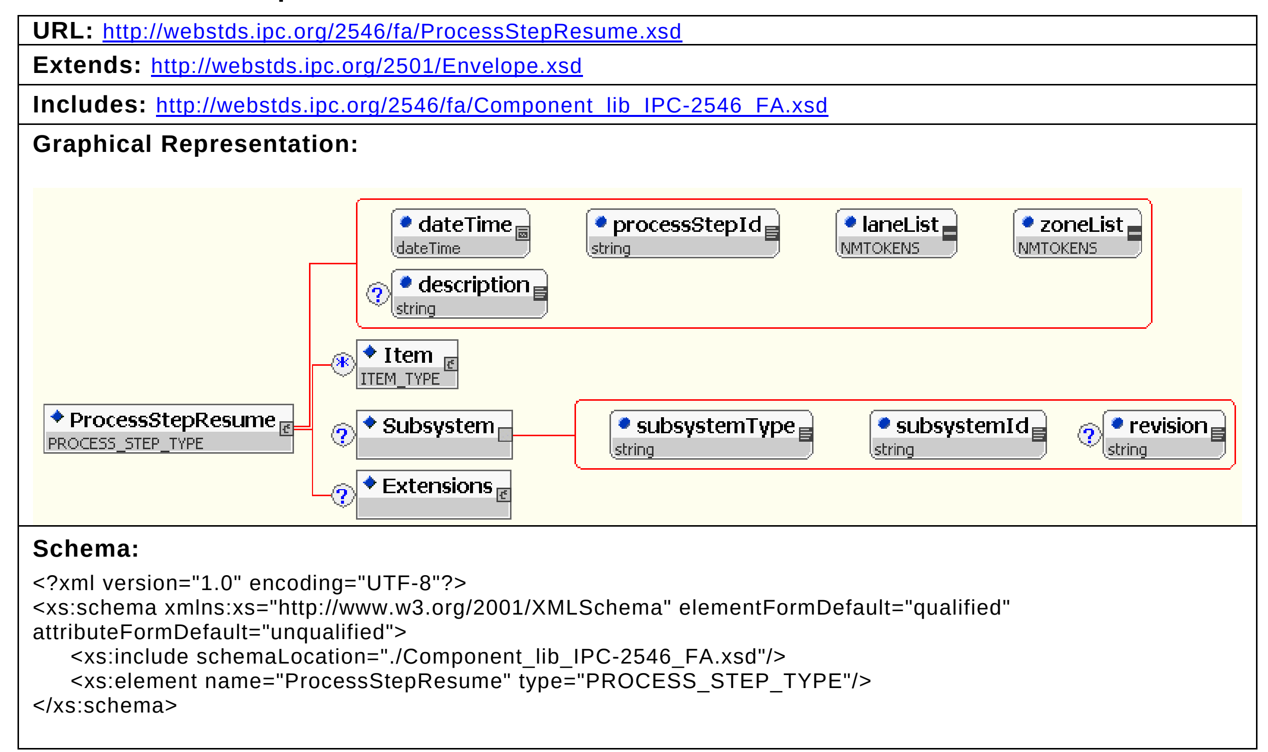
8.9.26 ProcessStepResume

URL: http://webstds.ipc.org/2546/fa/ProcessStepResume.xsd

Extends: http://webstds.ipc.org/2501/Envelope.xsd

Includes: http://webstds.ipc.org/2546/fa/Component_lib_IPC-2546_FA.xsd

Graphical Representation:



Schema:

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified"
attributeFormDefault="unqualified">
     <xs:include schemaLocation="./Component_lib_IPC-2546_FA.xsd"/>
     <xs:element name="ProcessStepResume" type="PROCESS_STEP_TYPE"/>
</xs:schema>
```

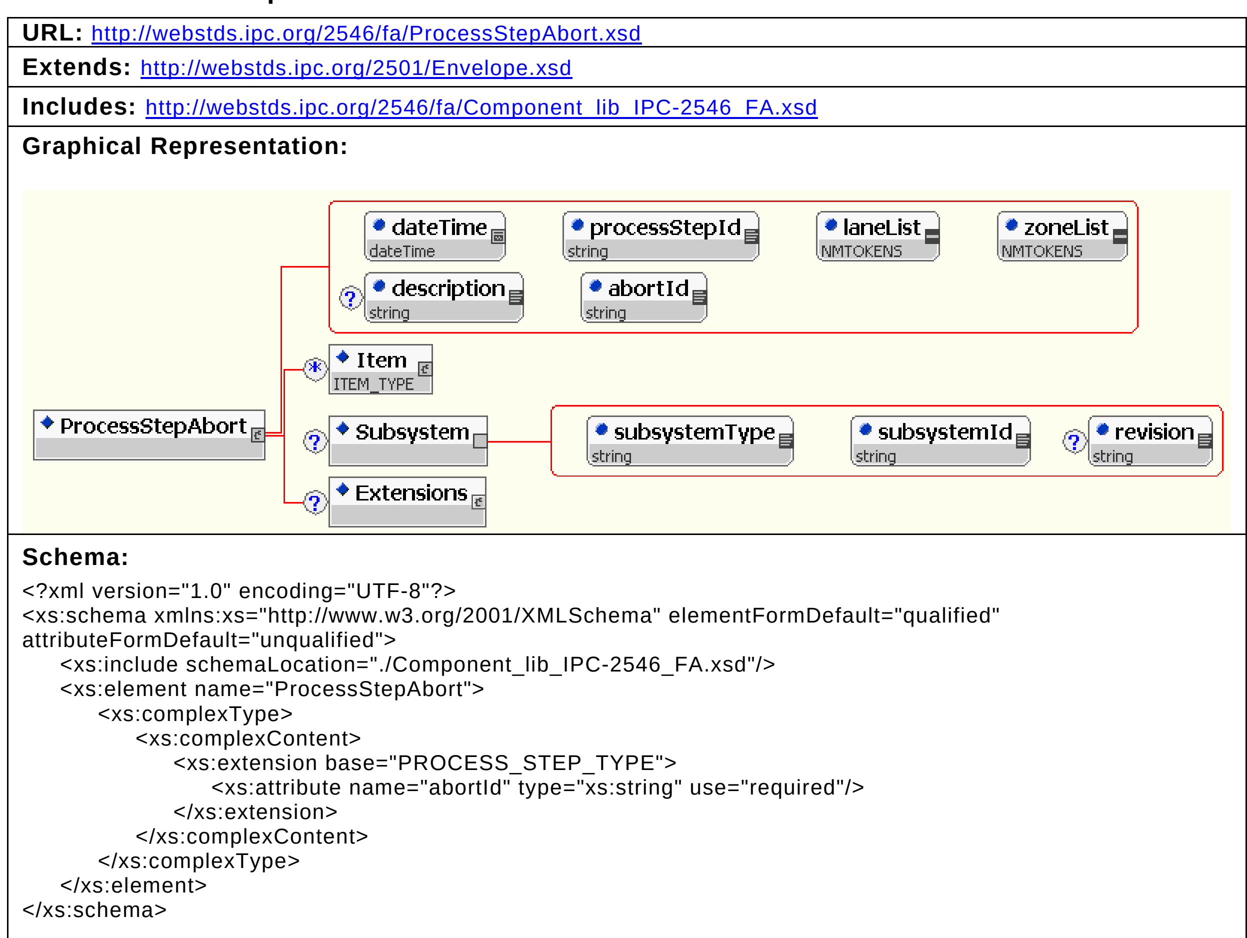
8.9.27 ProcessStepAbort

URL: http://webstds.ipc.org/2546/fa/ProcessStepAbort.xsd

Extends: http://webstds.ipc.org/2501/Envelope.xsd

Includes: http://webstds.ipc.org/2546/fa/Component_lib_IPC-2546_FA.xsd

Graphical Representation:



Schema:

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified"
attributeFormDefault="unqualified">
    <xs:include schemaLocation="./Component_lib_IPC-2546_FA.xsd"/>
    <xs:element name="ProcessStepAbort">
        <xs:complexType>
            <xs:complexContent>
                <xs:extension base="PROCESS_STEP_TYPE">
                    <xs:attribute name="abortId" type="xs:string" use="required"/>
                </xs:extension>
            </xs:complexContent>
        </xs:complexType>
    </xs:element>
</xs:schema>
```

8.9.28 ProcessStepComplete

URL: http://webstds.ipc.org/2546/fa/ProcessStepComplete.xsd

Extends: http://webstds.ipc.org/2501/Envelope.xsd

Includes: http://webstds.ipc.org/2546/fa/Component_lib_IPC-2546_FA.xsd

Graphical Representation:

ProcessStepComplete
dateTime dateTime
processStepId string
laneList NMTOKENS
zoneList NMTOKENS
description string
processStatus */string
Item ITEM_TYPE
Subsystem
subsystemType string
subsystemId string
revision string
Extensions

Schema:

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified"
attributeFormDefault="unqualified">
    <xs:include schemaLocation="./Component_lib_IPC-2546_FA.xsd"/>
    <xs:element name="ProcessStepComplete">
        <xs:complexType>
            <xs:complexContent>
                <xs:extension base="PROCESS_STEP_TYPE">
                    <xs:attribute name="processStatus" use="optional">
                        <xs:simpleType>
                            <xs:restriction base="xs:string">
                                <xs:enumeration value="OK"/>
                                <xs:enumeration value="FAILED"/>
                            </xs:restriction>
                        </xs:simpleType>
                    </xs:attribute>
                </xs:extension>
            </xs:complexContent>
        </xs:complexType>
    </xs:element>
</xs:schema>
```

Appendix A Implementation Guideline and Examples

A.1 Lane numbering example

Each equipment should have its own lane and zone naming. Labeling can be done internally corresponding to single equipment (Figure A-1) OR it can be extended to correspond full line width (Figure A-2) starting from nearest edge.

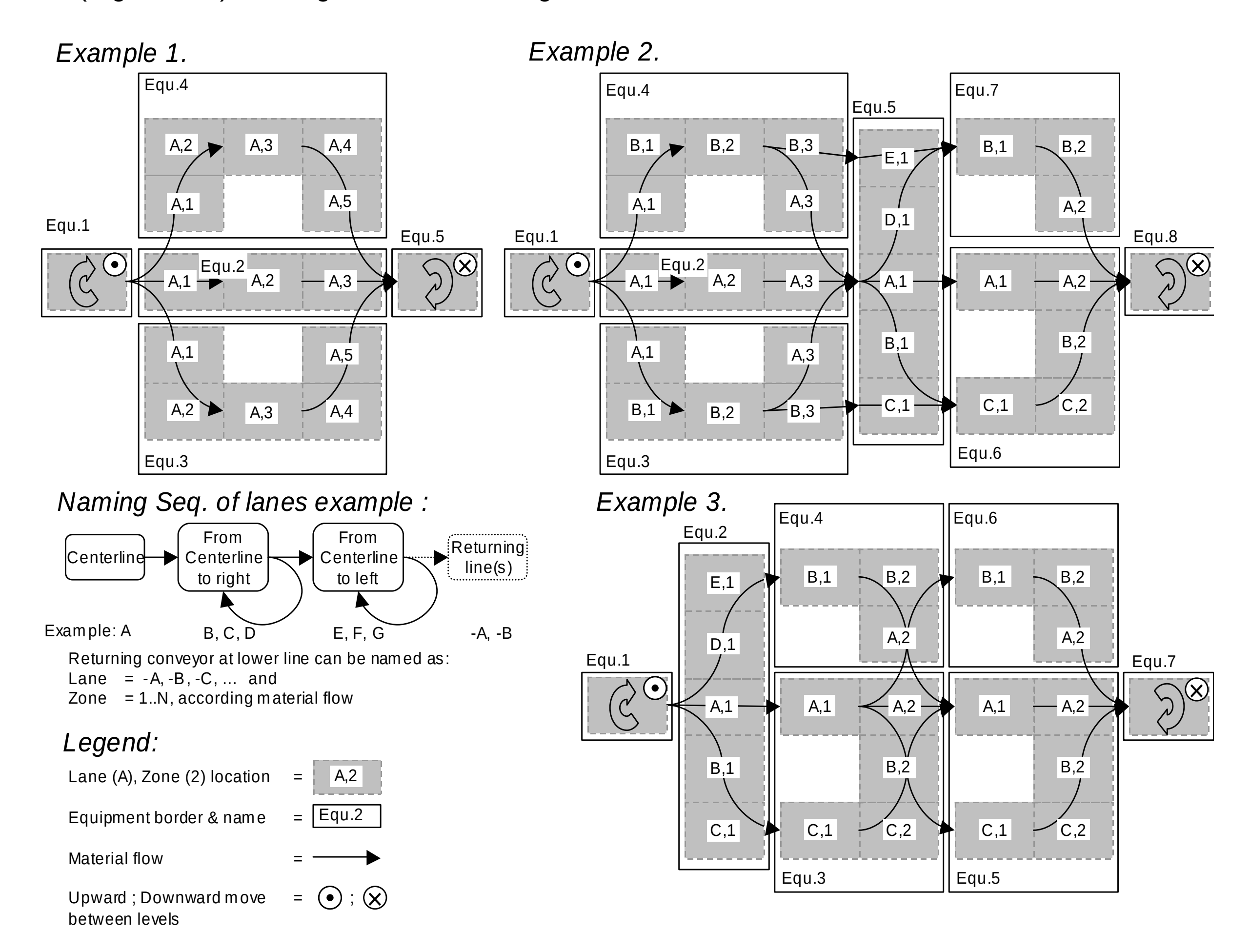


Figure A-1 Lane and Zone naming example 1

Lane numbering can be started from the center, and follow the lanes from centerline to right and then from centerline to left (e.g. Figure A-1; Example 3.; Equipment 2.). Negative lane numbers are reserved for returning material flow.

Zones are numbered in matrix format increasing in the direction of material flow. Matrix format refers to the grid pulled over the equipment, so that the lane changes lead into the same zone numbers. In case of bi-directional material flow, main material flow direction takes precedent.

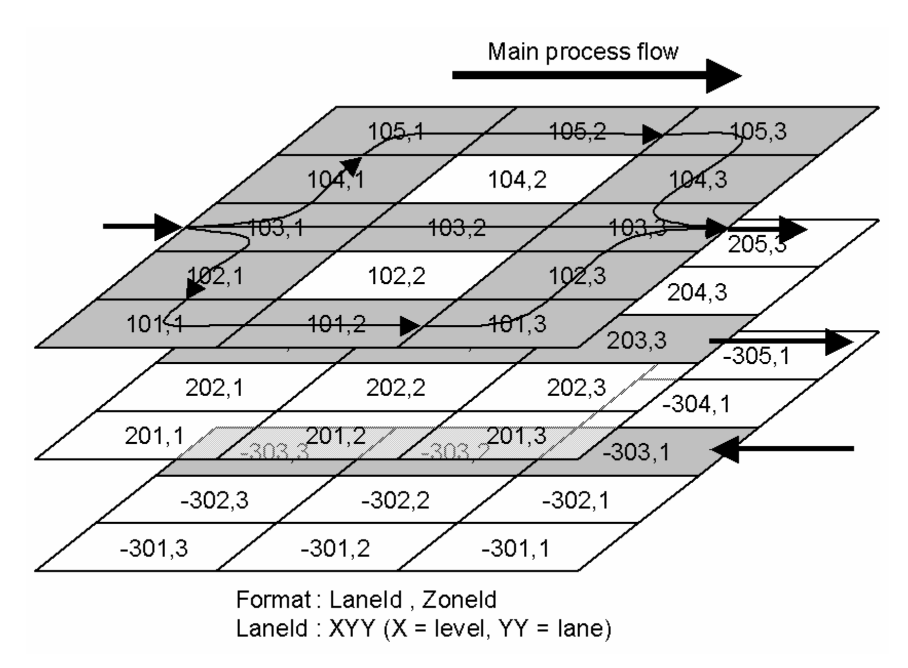


Figure A-2 Lane and Zone naming example 2

Naming of Lanes and Zones is equipment specific. Main recommendations are (See Figure A-2):

- Zone numbering is increasing in the direction of main process flow.
- Lane numbers are increasing from top to bottom and from nearest edge to farthest (when main process flow is from left to right)

The manufacturing execution system (MES) level should have the mapping of Lane, Zone pairs of two parallel pieces of equipment, if mapping is needed.

A.2 Equipments requesting unique Id addresses instead of Lane, Zone pairs

Equipment needing unique addresses, such as storage locations, or otherwise not consistent with the lane-zone naming convention can modify the convention as follows:

- Lane is kept in all cases as 1 (lane=”1”)
- Zone is replaced the unique identifiers e.g. from 1 to N or with other alphanumeric system.

A.2.1 Use of ItemIdentifier

ItemIdentifier can be used when an item has attached more than one identifier at the same time. Each identifier belongs into different namespace that is presented with idCategory attribute. The item cannot have at the same time two identifiers from the same namespace.

Example of this multi identifier case can be an item that has system identifier, lot/batch id, end user id and product id.

In case of BULK material like screws, plastic parts, boxes, which do not have unique identifier, the identifier can be empty. In this case term N/A (=not available) is used.

If item does not have unique identifier in specific namespace it can be classified as NONUNIQUE. This will be the situation in case of batch or lot identifier, when there exists several items with the same (group) identifier.

A.3 Timing of messages over assembly process

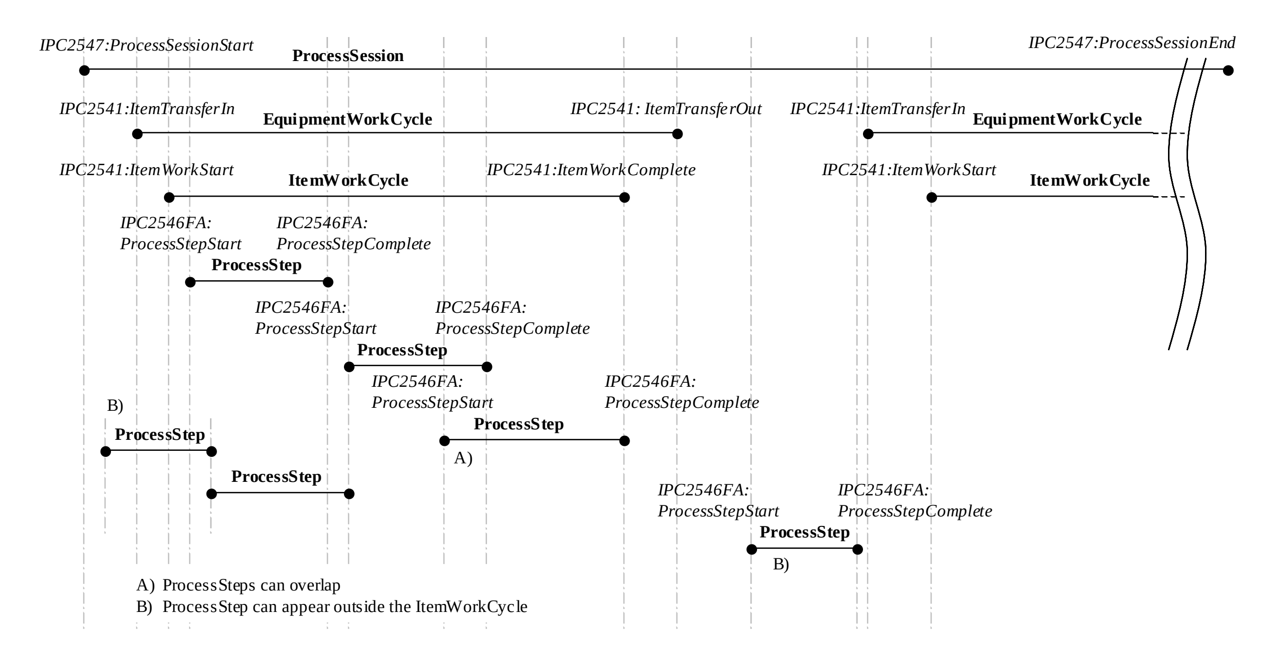


Figure A-3 Timing diagram of product assembly related messages

Example of a ProcessSteps:

Case1.: Joining a cover on product.

ProcessSteps:

1. Dispensing of glue on the product
2. Insertion of cover
3. Screw driving a screw 4x (one into each corner)

Case2.: Testing a product.

ProcessSteps:

1. Transportation of product to test station 1.5 sec
2. Testing 5.0 sec
3. Trasportation of product from test station 1.5 sec

Case3.: Insertion of laser marked cover to a product

ProcessSteps:

Parallel processSteps	
1.1 Transportation of product	2.1 Transportation of the cover 2.2 Laser marking of the cover 2.3 Transportation the marked cover
Parallel branches merging together 1.2 Joining the cover 1.3 Transportation of product out	

A.4 Usage of ItemChange

Reference: 5.9.7.2 Event: ItemChanged

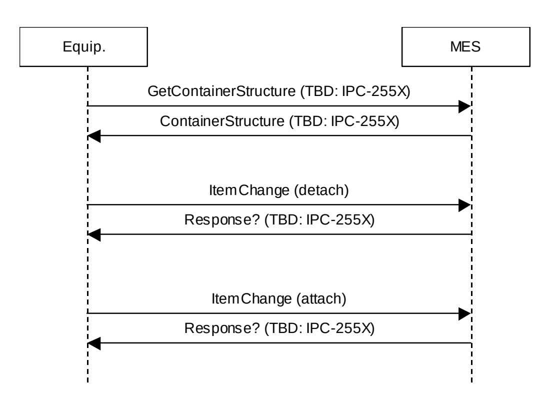


Figure A-4 Communication Scenario

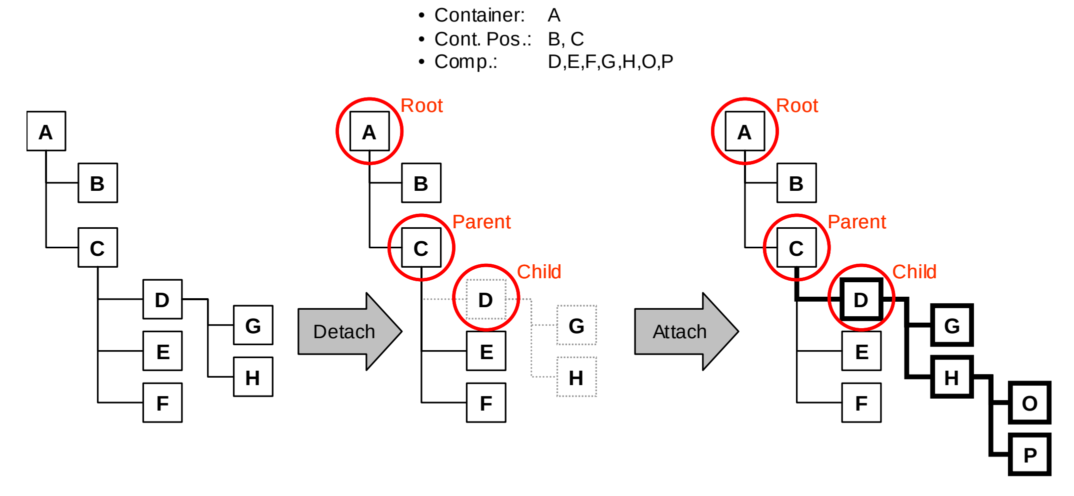


Figure A-5 Product structure under scope in example

Example:

1. Left side figure presents the original situation of the Container-Product tree.
2. Middle figure presents the situation after detach process. Item D has been removed from the assembly with the D's internal structure. Items referenced in the ItemChange message are circled, with the element name beside the circle.
3. Rightmost figure presents the following attach process. The item D has been assembled back into Item C. The whole structure of item D is presented and reported.

Descriptions and rules:

- RootItem and ParentItem do not need to present the structures of the child elements.
- If ContainerPosition element is in focus (any of RootItem, ParentItem or ChildItem) the focus should be moved to this ContainerPosition's parent (Container element). In this case the ContainerPosition must be presented together with the Item.
- ContainerPosition must be given with the parent, if its content is affected
- In attach operation the ChildItem can present its entire tree structure if necessary.
- In Detach operation the item does not need to present its sub-structure(s)
- ActionType="CREATE" is used for creation of totally new structure and to override possible existing structures (e.g. related to initialisation of a container).

A.5 Usage of Container route

Reference : 5.9.5.4 Element: Container and 5.9.7.2 Event: ItemChange.

The route can be presented as a list of locations or workphases the container should visit. This list can be stored to the attribute *routeInformation*, each location or workphase is presented in one of the tokens. The list of locations may be also formated some other way and the value can be presented with one single token.

Attribute *routeIndex*: Indexing is starting from 0,1,2,…,N. Index is about to present the pointer to certain location in the attribute *routeInformation* and to present the following workphase for the container.

A.6 Parameter value relations and ranges

Table presenting the different use cases of Parameter. See 5.9.4.3 FaProcessDataParameters, 5.9.5.11 DataNumeric and 5.9.6.1.2 ProcessParameterCaution.

application =	Case	Value	Description
EXPECTED	1.1.	Set-up Value	Single value as set-up point
	1.2.	Range of set-up value	Set-up value as range (Min and/or Max boundary)
MEASURED	2.1.	Measured value $T = t_1$	Single value is measured
	2.2	Range of measurement over continuous time span $\Delta T = t_0 - t_1$	Range of measurement is presented. Min and Max values.
ALARM_LIMITS	3.	Alarm limits	Alarm limits for the FaParameter. (Min and/or Max boundary). Severity of the alarm is selected with proper caution message (IPC-2541: Equip.Alarm, -Error or -Warning)

Example cases for the table:

Case 1.1.

```
<DataNumeric
      application="EXPECTED"
      units="METER"
      decade="-3"
      value="1500"/>
```

Case 1.2.

```
<DataNumeric
      application="EXPECTED"
      units="KELVIN"
      decade="0"
      minimum="297.15"
      maximum="299.15"
      comparator="GELE"/>
```

Case 2.1.

```
<DataNumeric
      application="MEASURED"
      units="METER"
      decade="-3"
      value="1500.45"/>
```

Case 2.2.

```
<DataNumeric
      application="MEASURED"
      units="KELVIN"
      decade="0"
      minimum="297.65"
      maximum="298.65"
      comparator="GELE"/>
```

Case 3.

```
<DataNumeric
      application=”ALARMLIMITS”
      units=”METER”
      decade=”-3”
      minimum=”-2000”
      maximum=”2000”
      comparator=”GELE”/>
```

Technical Questions

The IPC staff will research your technical question and attempt to find an appropriate specification interpretation or technical response. Please send your technical query to the technical department via:

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www.ipc.org e-mail: answers@ipc.org

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Our home page provides access to information about upcoming events, publications and videos, membership, and industry activities and services. Visit soon and often.

IPC Technical Forums

IPC technical forums are opportunities to network on the Internet. It's the best way to get the help you need today! Over 2,500 people are already taking advantage of the excellent peer networking available through e-mail forums provided by IPC. Members use them to get timely, relevant answers to their technical questions. Contact KeachSasamori@ipc.org for details. Here are a few of the forums offered.

TechNet@ipc.org

TechNet forum is for discussion of issues related to printed circuit board design, assembly, manufacturing, comments or questions on IPC specifications, or other technical inquiries. IPC also uses TechNet to announce meetings, important technical issues, surveys, etc.

ComplianceNet@ipc.org

ComplianceNet forum covers environmental, safety and related regulations or issues.

DesignersCouncil@ipc.org

Designers Council forum covers information on upcoming IPC Designers Council activities as well as information, comments, and feedback on current designer issues, local chapter meetings, new chapters forming, job opportunities and certification. In addition, IPC can set up a mailing list for your individual Chapter so that your chapter can share information about upcoming meetings, events and issues related specifically to your chapter.

Trainingnews@ipc.org

This is an announcement forum where subscribers can receive notice of new IPC Training Products.

leadfree.ipc.org

This forum acts as a peer interaction resource for staying on top of lead elimination activities worldwide and within IPC.

IPC_New_Releases@ipc.org

This is an announcement forum where subscribers can receive notice of new IPC publications, updates and standards.

ADMINISTERING YOUR SUBSCRIPTION STATUS:

All commands (such as subscribe and signoff) must be sent to listserv@ipc.org. Please DO NOT send any command to the mail list address, (i.e.<mail list> @ipc.org), as it would be distributed to all the subscribers.

Example for subscribing:
To: LISTSERV@IPC.ORG
Subject:
Message: subscribe TechNet Joseph H. Smith

Example for signing off:
To: LISTSERV@IPC.ORG
Subject:
Message: signoff DesignerCouncil

Please note you must send messages to the mail list address ONLY from the e-mail address to which you want to apply changes. In other words, if you want to sign off the mail list, you must send the signoff command from the address that you want removed from the mail list. Many participants find it helpful to signoff a list when travelling or on vacation and to resubscribe when back in the office.

How to post to a forum:

To send a message to all the people currently subscribed to the list, just send to <mail list>@ipc.org. Please note, use the mail list address that you want to reach in place of the <mail list> string in the above instructions.

Example:
To: TechNet@IPC.ORG
Subject: <your subject>
Message: <your message>

The associated e-mail message text will be distributed to everyone on the list, including the sender. Further information on how to access previous messages sent to the forums will be provided upon subscribing.

For more information, contact Keach Sasamori
tel: 847-597-2815 fax: 847-615-5615
e-mail: sasako@ipc.org www.ipc.org/emailforums

Education and Training

IPC conducts local educational workshops and national conferences to help you better understand conventional and emerging technologies. Members receive discounts on registration fees. Visit www.ipc.org to see what programs are coming to your area.

IPC Certification Programs

IPC provides world-class training and certification programs based on several widely-used IPC standards, including IPC-A-600, IPC-A-610, IPC/WHMA-A-620, J-STD-001 and IPC-7711A/7721A Rework and Repair. IPC-sponsored certification gives your company a competitive advantage and your workforce valuable recognition.

For more information on these programs:

tel: 847-597-2814	fax: 847-615-7105
e-mail: certification@ipc.org	www.ipc.org/certification

Designer Certification (C.I.D.)/Advanced Designer Certification (C.I.D.+)

Contact:

tel: 847-597-2827	fax: 847-615-5627
e-mail: christipoulsen@ipc.org	http://dc.ipc.org

EMS Program Manager Certification

Contact:

tel: 847-597-2884	fax: 847-615-5684
e-mail: susanfilz@ipc.org	www.ipc.org/certification

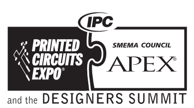
IPC Video Tapes and CD-ROMs

IPC video tapes and CD-ROMs can increase your industry know-how and on the job effectiveness. Members receive discounts on purchases.

For more information on IPC Video/CD Training, contact Mark Pritchard

tel: 505/758-7937 ext. 202	fax: 505/758-7938
e-mail: markp@ipcvideo.org	http://training.ipc.org

IPC Printed Circuits Expo, APEX and the Designers Summit



This yearly event is the largest electronics interconnection event in North America. With technical paper presentations, educational courses, standards development meetings networking opportunities and designers certification, there's something for everyone in the industry. The premier technical conference draws experts from around the globe. 500 exhibitors and 6,000 attendees typically participate each year. You'll see the latest in technologies, products and services and hear about the trends that affect us all. Go to www.GoIPCShows.org or contact shows@ipc.org for more information.

Exhibitor information:

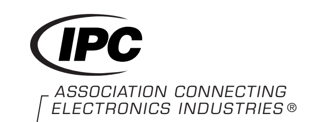
Mary Mac Kinnon	Alicia Balonek
Director, Show Sales	Director, Trade Show Operations
847-597-2886	847-597-2898
MaryMacKinnon@ip c.org	AliciaBalonek@ipc.org

How to Get Involved

The first step is to join IPC. An application for membership can be found in the back of this publication. Once you become a member, the opportunities to enhance your competitiveness are vast. Join a technical committee and learn from our industry's best while you help develop the standards for our industry. Participate in market research programs which forecast the future of our industry. Participate in Capitol Hill Day and lobby your Congressmen and Senators for better industry support. Pick from a wide variety of educational opportunities: workshops, tutorials, and conferences. More up-to-date details on IPC opportunities can be found on our web page: www.ipc.org.

For information on how to get involved, contact:
Jeanette Ferdman, Membership Director

tel: 847-597-2809	fax: 847-597-7105
e-mail: JeanetteFerdman@ipc.org	www.ipc.org



Application for Site Membership

Thank you for your decision to join IPC members on the "Intelligent Path to Competitiveness"! IPC Membership is **site specific,** which means that IPC member benefits are available to all individuals employed at the site designated on the other side of this application.

To help IPC serve your member site in the most efficient manner possible, please tell us what your facility does by choosing the most appropriate member category. *(Check one box only.)*

☐ Independent Printed Board Manufacturers

This facility manufactures and sells to other companies, printed wiring boards (PWBs) or other electronic interconnection products on the merchant market. What products do you make for sale?

☐ One-sided and two-sided rigid printed boards
☐ Multilayer printed boards
☐ Flexible printed boards
☐ Other interconnections

Name of Chief Executive Officer/President____

☐ Independent Electronic Assembly EMSI Companies

This facility assembles printed wiring boards, on a contract basis, and may offer other electronic interconnection products for sale.

Name of Chief Executive Officer/President____

☐ OEM–Manufacturers of any end product using PCB/PCAs or Captive Manufacturers of PCBs/PCAs

This facility purchases, uses and/or manufactures printed wiring boards or other interconnection products for use in a final product, which we manufacture and sell.

What is your company's primary product line? ____

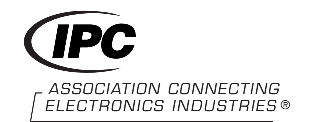
☐ Industry Suppliers

This facility supplies raw materials, machinery, equipment or services used in the manufacture or assembly of electronic interconnection products.

What products do you supply?____

☐ Government Agencies/Academic Technical Liaisons

We are representatives of a government agency, university, college, technical institute who are directly concerned with design, research, and utilization of electronic interconnection devices. (Must be a non-profit or not-for-profit organization.)



Application for Site Membership

Site Information:

Company Name

Street Address

City | State | Zip/Postal Code | Country

Main Switchboard Phone No. | Main Fax

Name of Primary Contact

Title | Mail Stop

Phone | Fax | e-mail

Company e-mail address | W

Please Check One:

☐ $1,000.00 Annual dues for Primary Site Membership (Twelve months of IPC membership begins from the time the application and payment are received)

☐ $800.00 Annual dues for Additional Facility Membership: Additional membership for a site within an organization where another site is considered to be the primary IPC member.

☐ $600.00** Annual dues for an independent PCB/PWA fabricator or independent EMSI provider with annual sales of less than $1,000,000.00. **Please provide proof of annual sales.

☐ $250.00 Annual dues for Government Agency/not-for-profit organization

TMRC Membership ☐ Please send me information about membership in the Technology Market Research Council (TMRC)

Payment Information:

Enclosed is our check for $________________

Please bill my credit card: (circle one) MC AMEX VISA DINERS

Card No.____Exp date_______________

Authorized Signature

____

Mail application with check or money order to:

IPC
3491 Eagle Way
Chicago, IL 60678-1349

Fax/Mail application with credit card payment to:

IPC
3000 Lakeside Drive, Suite 309 S
Bannockburn, IL 60015-1249
Tel: 847-615-7100
Fax: 847-615-7105
http://www.ipc.org

Please attach business card
of primary contact here